CHAPTER IV

LAND USE ECOSYSTEMS AND ENVIRONMENTAL ISSUES IN MYANMAR: AN OVERVIEW

The present chapter is an attempt to discuss the environmental situation of Myanmar. It also focuses on the current environmental problems in the country. The chapter is divided into two sections. Section one focuses on the land cover and various ecosystems of Myanmar, while section two looks at the major environmental problems from a regional perspective with a focus on low and high production regions of Myanmar.

Section (I)

Land use And Resources in Myanmar

4.1(a) Nature in Myanmar Literature and Arts

In Myanmar literature and arts, one finds appreciation of natural surroundings. Nature is the major theme in the composition of poems and songs, and pastoral life is the favourite of Myanmar play rights, Myanmar theatrical arts display the same vain.

Myanmar dramatists choose natural environments for lovers, rendezvous because its enchanting audience is unsurprisingly romantic. When the Buddhism became the dominant faith professed by a great majority in Myanmar it permeated every aspect of Myanmar life. Due to Buddhist teaching, love and respect for natural environment was ingrained in Myanmar culture. Planting of trees and developing natural forests with arboreta as an act of religious merit are found recorded in some stone inscriptions at old Bagan.

In the month of Kason (June) the festival of ceremonially pouring fresh water on the sacred Bodh tree is held and as a life saving act of charity. Fishes and turtles from nearby dry ponds and lakes are taken to places where there is abundant water. The
ecological practice of festival in Kason is a sort of public activity in the preservation of natural environment. Different months of the year have special flowers associated with them suggesting a close link between nature and daily life (see Table 4.1).

Table 4.1 Calendar months of Myanmar associated with the names of seasonal flowers

<table>
<thead>
<tr>
<th>Sr No</th>
<th>Name of Month</th>
<th>Astrological Name of the Month</th>
<th>Name of Seasonal Flower</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Tagu (April)</td>
<td>Mesha (Aries)</td>
<td>Gantgaw (Mesuaferrea)</td>
</tr>
<tr>
<td>02</td>
<td>Kason (May)</td>
<td>Vrishabha (Taurus)</td>
<td>Sagar (Champee Michelis)</td>
</tr>
<tr>
<td>03</td>
<td>Nayon (June)</td>
<td>Mithuna (Gemini)</td>
<td>Sabai (Jasmine)</td>
</tr>
<tr>
<td>04</td>
<td>Waso (July)</td>
<td>Kataka (Cancer)</td>
<td>Myatlay (Spanish Jasmine)</td>
</tr>
<tr>
<td>05</td>
<td>Wakhaung (August)</td>
<td>Simha (Leo)</td>
<td>Khatta-Land Lily (Ginum Nimaruam)</td>
</tr>
<tr>
<td>06</td>
<td>Tawthalin (September)</td>
<td>Kanya (Virgo)</td>
<td>Yinmar (Chukrasisabularis)</td>
</tr>
<tr>
<td>07</td>
<td>Thadinkyut (October)</td>
<td>Tula (Libra)</td>
<td>Kya (Water Lilies) Lotus (Nelumbo nucifere)</td>
</tr>
<tr>
<td>08</td>
<td>Tarzaungmone (Nov)</td>
<td>Vrischika (Scorpio)</td>
<td>Khawei (ridged guard)</td>
</tr>
<tr>
<td>09</td>
<td>Nattaw (December)</td>
<td>Dhanika (Sagarittus)</td>
<td>Thazin (Orchid)</td>
</tr>
<tr>
<td>10</td>
<td>Pyatho (January)</td>
<td>Mahara (Capricorn)</td>
<td>Khwanyo (Clematis Gabian)</td>
</tr>
<tr>
<td>11</td>
<td>Tabodwe (February)</td>
<td>Kumbha (Aquarious)</td>
<td>Pauk (Butea minospemric)</td>
</tr>
<tr>
<td>12</td>
<td>Tabaung (March)</td>
<td>Mire (Pieces)</td>
<td>Tharaphi&amp;ponnyet(Ochiocapres Siamensis and (Calaphylhem Inophyllum)</td>
</tr>
</tbody>
</table>


4.1 (b) Ecosystems and Natural Resources endowment of Myanmar

Myanmar has a wide variety of natural ecosystems ranging from land and forest ecosystems to marine, coastal and mountain ecosystems. These various ecosystems provide the country with rich natural resources. Land ecosystems include croplands, grasslands; grazing lands, woodlands and forestlands. According to an assessment made in 1989, of the total land area of 676553 km$^2$, the total area under cultivation is 79940 km$^2$ or about 12 percent of the total land area and forests cover 344237 km$^2$, which is 51 percent of the total land area. This is due to the fact that Myanmar forests have been prudently managed over the decades and sustainable exploitation of timber carried under the Myanmar selection system. In Myanmar selected system, the forest area is divided into 30 blocks of equal yield capacity. Each year, selection fellings are carried out in one of these blocks and the whole forest is therefore worked over felling cycle of thirty years.
Under this system when felling becomes due, all marketable trees, which have attained a fixed exploitable girth size, are selected for cutting. The fixed exploitable girth size varies with the type of forest. In good (moist) teak forest the girth limits at breast height 3m (4'6") 75 cm dbh (7'6"gbh) and in poor (dry) forest 65 cm dbh (6'6"gbh). Unhealthy trees that have not attained these sizes, but are marketable, are also selected for cutting if they are unlikely to survive through the subsequent felling cycle, if seed bearers are scarce a few high quality stem should be retained as seed trees. The same system of management is applied for hardwoods, with the exception that the girth limit fixed depends upon tree species. For the local supply working circle, coppice with standard or clear felling system is applied. Myanmar forests provide valuable products such as teak and hardwood and harbour a large variety of biological species, infact Myanmar teak is well known for its quality.

The wide variety of forest types including mangroves provide for a rich diversity of flora and fauna. As a result of its unusual ecological diversity, Myanmar is home to over 1000 species of birds, more than 300 known mammal species, and 700 hundreds of reptiles and amphibians, 1347 species of big trees, 741 species of small trees, 1696 species of shrubs, 96 species of bamboo, 36 species of rattan and 841 species of orchids so far recorded (Anon, 1993).

Inland water bodies' likes natural lakes, reservoirs, river systems, and ponds cover a total area of about 13327 km$^2$. Inland water systems together with the annual rainfalls provide vast amount of water resources for the country. Wetlands are found in many parts of the country. The principal wetlands are mangroves, swamp forests, lakes, and marshes. Mangrove forests in Myanmar are an important source of wood fuel and charcoal and provide habitat and shelter for estuarine fish, shrimps, prawns, birds, reptiles and many other kinds of wildlife.

According to Peter Gutter (2001), Myanmar is one of Asia's naturally richest countries. Its diverse ecosystem ranges from the Himalayas to the tropical reefs along the Bay of Bengal. Fertile agricultural lowlands once made Myanmar a leading rice exporter.
Its fishing ground was among the world's most bountiful. Its immense native rain forests, some of the last remaining in all of Asia, are home to numerous endangered plants and animals. It is however, noticeable that the biological resources have deteriorated over the decades due to disturbances caused by humans and fragmentation of habitats. In 1974, forests covered about 498,676 sq.km or 74% of the whole country, out of which 51% were closed and degraded forests. During the fourteen year period from 1975 to 1989 the total forest cover had been reduced at the rate of 15,000 ha per year. Deforestation in Myanmar, unlike in some other developing countries is not only the result of commercial extraction of timber but also due to shifting cultivation, fuel-wood problem and to a certain extent, population growth. Shifting cultivation is practiced by about 2.6 million people mostly living in the Kachin, Kayah, Kayin, Chin and Shan states covering an area of about 1,42,000 hectares.

In Myanmar, more than 90 per cent of renewable energy consumption depends upon forests resources. Few rural homes in Myanmar have supply of gas of electricity. Thus, there is heavy reliance on fuel wood resulting in depletion of forest cover in marginal forests outside the reserved forest areas. Though Myanmar selection system has enabled the country to use its forest resources on a sustainable basis, it has been estimated that in the year 2000, as the population reached 50 million, the demand for wood fuel also increased accordingly.

4.2 Land Cover Distribution and Assessment

Myanmar is forest-clad with over 50% of forest cover. The coverage included closed forests and degraded forest either affected by shifting cultivation or otherwise. Degraded forests affected by shifting cultivation are not included under the forest cover of fifty percent. In general, rain forests occur on the west facing slopes of the mountains that run south to north along the western and eastern frontiers. Some tropical evergreen forests occur in the extreme south, but most of the rain forests are semi-evergreen (Collins, et al, 1991). Stands in the drier areas are deciduous and also fire resistant to some extent. Table (4.2.a& b) and Fig (4.1) show the land cover type distribution and their extent. Combining the figure of the evergreen, deciduous and mangrove forests,
they accounted for 44% forest cover of the country. However, upon comparing the scrubland formation appeared in (Fig 4.1) with the 1991 National Forest Management and Inventory results, such land cover type not only falls under the degraded forest but also includes portion of the closed forest affected by shifting cultivation.

Majority of the evergreen forests are being accommodated by Kachin State in the north and Taninthayi Division in the south. In addition, these lush evergreen forests where the annual rainfall normally exceeds 70 inches also cover significant areas along the slopes of Rakhine, Shan States, and Sagaing Division.

**Table 4.2.a**  Land cover type and extent in Myanmar, 1985-1986

<table>
<thead>
<tr>
<th>Land Cover Category</th>
<th>Area (sq.km.)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evergreen Forest</td>
<td>232211.8</td>
<td>35.1</td>
</tr>
<tr>
<td>Deciduous Forest</td>
<td>95930.6</td>
<td>14.5</td>
</tr>
<tr>
<td>Mangrove Forest</td>
<td>1826.7</td>
<td>0.3</td>
</tr>
<tr>
<td>Scrubland</td>
<td>193816.3</td>
<td>29.3</td>
</tr>
<tr>
<td>Agriculture</td>
<td>114051.6</td>
<td>17.3</td>
</tr>
<tr>
<td>Water Bodies</td>
<td>1676.0</td>
<td>0.3</td>
</tr>
<tr>
<td>No data available (cloud covered)</td>
<td>21407.9</td>
<td>3.2</td>
</tr>
</tbody>
</table>

*Source: NOAA A VHRR Satellite Data, 1992.*

**Table 4.2.b**  Land cover type and extent in Myanmar, 1992-1993

<table>
<thead>
<tr>
<th>Land Cover Category</th>
<th>Area (sq.km.)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evergreen Forest</td>
<td>203245.9</td>
<td>30.8</td>
</tr>
<tr>
<td>Deciduous Forest</td>
<td>84955.2</td>
<td>12.9</td>
</tr>
<tr>
<td>Mangrove Forest</td>
<td>1823.8</td>
<td>0.3</td>
</tr>
<tr>
<td>Scrubland</td>
<td>220676.3</td>
<td>33.4</td>
</tr>
<tr>
<td>Agriculture</td>
<td>138252.2</td>
<td>20.9</td>
</tr>
<tr>
<td>Water Bodies</td>
<td>1036.4</td>
<td>0.2</td>
</tr>
<tr>
<td>No data available (cloud covered)</td>
<td>10908.1</td>
<td>1.7</td>
</tr>
</tbody>
</table>

*Source: NOAA A VHRR Satellite Data,(1993).*
Figure 4.1  Myanmar Land Cover 1985-1986 by NOAA AVHRR
The three northern administrative groups of Kachin, Chin, and Sagaing hold the higher hectarage of the deciduous formations that are fairly distributed along the plateau of the Shan State where the altitude rarely overshoots an approximate 1000 m (Table 4.3). The dry deciduous forest along the vast stretch of the Ayeyawady plain typically covers the Bago and eastern side of Rakhine Yomas. It was believed that bamboos of several species are abundant especially in the Rakhine Yoma. Despite their conspicuous green feature, gregarious nature or often associated with other tree species their certainty to be distinguished with the use of AVHRR was found complicated. Nevertheless, local reports specified that generally, bamboos and canes are common associates occurring as under storey of the deciduous and evergreen forests. However, lower mixed deciduous forest does not have bamboos (Fig 4.2).

The heavily populated Ayeyawady plains, now almost entirely cleared for agriculture, lie in the rain shadow of the western ranges and especially in the central area have a very dry and seasonal climate. This area also supports the dry deciduous woodland and tropical thorn forest. Large areas under cultivation were dominant in the Ayeyawady plain that also extends as far as Sagaing division in the north. Because of the course spatial resolution of the AVHRR data, it was noted that small patches of cultivated fields along the slopes were categorized as part of the scrubland. Moreover, four considerable patches of cultivated land can be noticed in the coastal areas of Rakhine, hilly sections of Shan, Kayin, and Mon States. It can also be observed that the increasing proportion of agricultural areas tends to be parallel with the increasing share of the scrubland. This hold true especially in the States of Kayah, Mon, Kayin, and Shan (see Table 4.3) lists the land cover type distribution for different States/Divisions in Myanmar.
Figure 4.2 Myanmar Land Cover 1992-1993 by NOAA AVHRR
### Table 4.3  Myanmar States and Divisions: Population and Non-forest area (1992-1993)

<table>
<thead>
<tr>
<th>States &amp; Divisions</th>
<th>Population (000)*</th>
<th>Population/ sq.km. (1990)</th>
<th>Agriculture (sq.km.)</th>
<th>%</th>
<th>Scrubland (sq.km.)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1986</td>
<td>1990</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ayeyawady Division</td>
<td>5322</td>
<td>5703</td>
<td>179.0</td>
<td>51.8</td>
<td>11046.1</td>
<td>34.7</td>
</tr>
<tr>
<td>Bago Division</td>
<td>4032</td>
<td>4310</td>
<td>114.7</td>
<td>37.8</td>
<td>11916.6</td>
<td>31.7</td>
</tr>
<tr>
<td>Chin State</td>
<td>388</td>
<td>411</td>
<td>11.3</td>
<td>0.6</td>
<td>13914.9</td>
<td>38.2</td>
</tr>
<tr>
<td>Kachin State</td>
<td>972</td>
<td>1052</td>
<td>11.7</td>
<td>1.6</td>
<td>4354.6</td>
<td>4.8</td>
</tr>
<tr>
<td>Kayah State</td>
<td>186</td>
<td>206</td>
<td>17.8</td>
<td>16.1</td>
<td>6090.1</td>
<td>52.6</td>
</tr>
<tr>
<td>Kayin State</td>
<td>1132</td>
<td>1225</td>
<td>39.5</td>
<td>14.7</td>
<td>13466.5</td>
<td>43.5</td>
</tr>
<tr>
<td>Magway Division</td>
<td>3483</td>
<td>3771</td>
<td>85.0</td>
<td>50.5</td>
<td>19548.3</td>
<td>44.1</td>
</tr>
<tr>
<td>Mandalay Division</td>
<td>4936</td>
<td>5370</td>
<td>144.5</td>
<td>51.5</td>
<td>11162.2</td>
<td>30.0</td>
</tr>
<tr>
<td>Mon State</td>
<td>1822</td>
<td>1996</td>
<td>184.6</td>
<td>30.7</td>
<td>5761.9</td>
<td>53.3</td>
</tr>
<tr>
<td>Rakhine State</td>
<td>2176</td>
<td>2328</td>
<td>71.6</td>
<td>19.6</td>
<td>6077.8</td>
<td>18.7</td>
</tr>
<tr>
<td>Sagaing Division</td>
<td>4155</td>
<td>4514</td>
<td>47.7</td>
<td>26.2</td>
<td>22567.8</td>
<td>23.9</td>
</tr>
<tr>
<td>Shan State</td>
<td>3923</td>
<td>4162</td>
<td>26.6</td>
<td>6.9</td>
<td>79014.3</td>
<td>50.4</td>
</tr>
<tr>
<td>Tanintharyi Division</td>
<td>995</td>
<td>1089</td>
<td>25.5</td>
<td>2.0</td>
<td>8932.2</td>
<td>20.9</td>
</tr>
<tr>
<td>Yangon Division</td>
<td>4278</td>
<td>4649</td>
<td>486.1</td>
<td>67.0</td>
<td>1956.0</td>
<td>20.5</td>
</tr>
</tbody>
</table>


In the uplands of Myanmar, shifting cultivation is still the major agent of forest destruction. All forest types are affected by rising populations of itinerant farmers is steadily eating into the forest. Moreover, the increasing population pressure has led to a reduction in the number of years of the felling cycle and has forced farmers to penetrate further and further into the forest. The impact is more acute in the remote hill areas. Very large areas of forest have been cleared in eastern Shan State, Kayah State, Sagaing Division, and Chin State (Collins, 1991).
Table (4.3) indicates that population of Myanmar is highly distributed among the six states/divisions located in the Ayeyawady Plain such as divisions of Yangon, Ayeyawady, Bago, Mandalay and Magway with the inclusion of Sagaing Division. The distribution of large tract of cultivated area also follows the state or division where concentration of population is denser. An average of 176.2 individual /sq.km is exhibited by the six states/divisions along the plain of Ayeyawady. In addition, the Shan State, a predominant hilly area which is one of the biggest state in the country holds a high number of populace. It’s combined agricultural area and scrubland comprises a considerable 57% of its total area. At least half of the landscape of adjoining states of Shan Plateau such as the Kayah, Kayin, and Mon are considered as non-forest, wherein the proliferations of sparse woody vegetation in association with cultivated areas are abundant.

In a span of seven years, from1985-1986 to 1992-1993, land cover change exhibited a typical vegetation transformation similar with other Asian countries. As shifting cultivation continue to play a major role in land degradation, converting evergreen forest to mixed deciduous, dry deciduous forest becomes dominant (Table 4.2.b and Fig 4. 2). Moreover, in highly populated areas, repeated cuttings for domestic uses have transformed many of these magnificent stands into stunted scrub forest. The advancement of scrubland formation into the belt of either deciduous or evergreen group is the more apparent kind of land cover conversion. Besides, the encroachment of agricultural areas in adjacent forest accelerates the conversion into non-forest type.

Scrubland typically fragmented and found in remote hill country occupies a considerable proportion in Mon State (53.3%), Kayah State (52.6%), Shan State (50.4%), and also in Magway Division and Kayin State. The increasing proportion of agricultural land as it moves deeper within the extent of scrubland formations became more apparent not only on the plains but also in steep slopes. Most of the disturbed forests have given their way for the expanding agricultural area where environmental condition permits. A very quick, generalization can be observed from the (1992-1993) and (1985-1986) Land Cover Maps of Myanmar from AVHRR, that both agricultural area and scrubland exhibit
conspicuous increase in terms of their extent. The Ayeyawady plain especially in the northern region, the coastal area of Rakhine State, and the Shan plateau are the common places of agricultural expansion (see Table 4.3).

It has been known that the management of the evergreen forest in Myanmar is a recent phenomenon largely in response to worldwide demand for wood and non-wood products due to the depletion of tropical hardwood resources in neighboring countries. The goal in management, however, is the development and maintenance of a commercially productive forest, which may be, or more likely, may not be identical in composition to the climax forest. There is also an urgent need to strengthen the knowledge base on the silvicultural and management characteristics of the extremely rich and diverse species that comprise the evergreen forest, (Than, 1992).

In the case of Myanmar, the predominant shifting cultivation practices signify a gradual but chronic degradation of the landscape in line with the nature of land transformation. As shifting cultivation continues to play a dominant role in forest type conversion, the typical transformation from one type of vegetation to another is apparent, especially for the increasing proportion of open woodlands and dry deciduous group from the original evergreen or semi-evergreen type. Yet, the expansion of originally recognized scrubland that denotes mostly the presence of crop cultivation is the main feature of land degradation. Such landscape modifications as discerned in the time series analysis of AVHRR data subsequently lead to increased attention for a deeper investigation of the area. The use of high-resolution satellite data supplemented by field information is of vital importance. This will serve as an early warning system towards preventive measures in areas exhibiting major land transformation or active deforestation.

### 4.3 Forest Resources

The analysis of 1989 Landsat tone image had indicated that Myanmar is still endowed with one of the most extensive natural forest cover in the world with 43% of its area under closed forest and another 30% under woodlands. The status of forest cover
in 1989 is given in (Table 4.4).

### Table 4.4 Forest cover of Myanmar (1989)

<table>
<thead>
<tr>
<th>No</th>
<th>Land category</th>
<th>Area (sq.km)</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Closed forests</td>
<td>293269</td>
<td>43.34</td>
</tr>
<tr>
<td>2</td>
<td>Degraded forest</td>
<td>50968</td>
<td>7.53</td>
</tr>
<tr>
<td>3</td>
<td>Forest affected by shifting cultivation</td>
<td>154389</td>
<td>22.82</td>
</tr>
<tr>
<td>4</td>
<td>Water bodies</td>
<td>13327</td>
<td>2.01</td>
</tr>
<tr>
<td>5</td>
<td>Non-forest</td>
<td>164600</td>
<td>24.30</td>
</tr>
<tr>
<td>6</td>
<td>Total</td>
<td>676,553</td>
<td>100</td>
</tr>
</tbody>
</table>

*Source: Forest Fact sheet, Myanmar, 1993.*

Close and degraded forest, which can be considered as actual forest cover constituted 344,237 Km$^2$ or approximately 51% of the total area of the country. The assessment of the change in forest cover conducted in 1990 revealed that the actual forest cover had decreased at an annual rate of 220,000 ha or 0.64% of the actual forested area during a period of 14 years from 1975 to 1989. This was mainly due to shifting cultivation, illicit cutting, and encroachment for agriculture purposes.

In 1995, of the total land area, 3 88,500 sq.km (57 per cent) is forest; of that area, 103,600 sq.km constitute reserved forests and 284,900 sq.km comprise public forests (unclassified forests).

#### 4.3.1 Timber resources

The forests comprise numerous timber species, including the most valuable timber, teak. Associated with teak are other important hardwoods such as Pyinkado and Padauk. The Dipterocarp and sub-alpine forests, mangroves and estuarine and bamboo forests all contribute to providing some 1,200 timber species and 780 varieties of small trees. Currently, however, only about 45 species are being exploited.
The forestry sector registered significant increase in 1989-90 as a result of grants on the tender system to cooperatives and private sector for extracting hardwood and other forest products other than teak. Granting logging concessions was terminated in December 1993. The sale of logs in foreign currency, however, is done occasionally through systematic tender systems by the Myanmar Timber Enterprise.

Out of the 2088 trees species, 85 have been re-formed and accepted as producing multiple use of premium quality timber. Studies on the properties and utilization of the lesser-used timber species are being done, and their utility extensively promoted. The attempt is to increase commercial production and reduce the pressure on the premium quality timber. Forest area of the country has been estimated by forest types and is shown in (Table 4.5) Forest area by types of Forest. The forest area may also be divided by type of vegetation and productivity as shown in (Table 4.6). The volume of growing stock of timber is shown in (Table 4.7). The table shows that the forests in Myanmar contain some 2.2 billion cubic meter of standing growing stock of timber. The total annual growth would mount to 31 million cubic meters of the commercially exploitable production forests. 103090 sq.km (15.2% of the country) are reserved forests while 270,677 sq.km (35.6%) are other forests. Apart from the production forests there are some 7731 sq.km of protected forests covering 1.14% of the country.
### Table 4.5  Forest area by types of forest

<table>
<thead>
<tr>
<th>Types of vegetation</th>
<th>Productive forest (Mill in ha)</th>
<th>Unproductive forest</th>
<th>Grand total (Mill In ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Closed broad leaf</td>
<td>1859</td>
<td>357</td>
<td>2216</td>
</tr>
<tr>
<td>Mangrove</td>
<td>12</td>
<td>4</td>
<td>16</td>
</tr>
<tr>
<td>Conifer</td>
<td>16</td>
<td>-</td>
<td>16</td>
</tr>
<tr>
<td>Total</td>
<td>1887</td>
<td>381</td>
<td>2248</td>
</tr>
</tbody>
</table>

Source: Kyaw Tint, 1995

### Table 4.6  Forest area by types of vegetation in hectares

<table>
<thead>
<tr>
<th>No</th>
<th>Types of vegetation</th>
<th>Productive forest</th>
<th>Unproductive forest</th>
<th>Total (000) ha In ha.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Closed broad leafed</td>
<td>20655</td>
<td>11908</td>
<td>32563</td>
</tr>
<tr>
<td>2</td>
<td>Mangrove</td>
<td>382</td>
<td>403</td>
<td>785</td>
</tr>
<tr>
<td>3</td>
<td>Bamboo</td>
<td>963</td>
<td>-</td>
<td>963</td>
</tr>
<tr>
<td>4</td>
<td>Conifer</td>
<td>113</td>
<td>-</td>
<td>113</td>
</tr>
<tr>
<td>5</td>
<td>Total</td>
<td>22113</td>
<td>12311</td>
<td>34427</td>
</tr>
</tbody>
</table>

Source: Kyaw Tint, 1995

### Table 4.7  Volume of growing stock of timber (Million in ha)

<table>
<thead>
<tr>
<th>Sr.No</th>
<th>Types of forest</th>
<th>Area in ha.</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Tidal beach &amp; swamp forest</td>
<td>1376900</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>Tropical evergreen forest</td>
<td>5507800</td>
<td>16</td>
</tr>
<tr>
<td>3</td>
<td>Mixed deciduous forest</td>
<td>13425300</td>
<td>39</td>
</tr>
<tr>
<td>4</td>
<td>Dry forest</td>
<td>3442400</td>
<td>10</td>
</tr>
<tr>
<td>5</td>
<td>Deciduous dipterocarp forest</td>
<td>1721200</td>
<td>6</td>
</tr>
<tr>
<td>6</td>
<td>Hill &amp; temperate evergreen fore</td>
<td>8950100</td>
<td>26</td>
</tr>
<tr>
<td>7</td>
<td>Total</td>
<td>34423700</td>
<td>100.00</td>
</tr>
</tbody>
</table>

4.3.2 Plantation Resources

An attempt on raising teak plantation using Taungya (shifting cultivation) (agro forestry) method was first made in 1856. The success with this method led to a wide spread planting of teak, Acacia catechu, and xylia Kerri, and by 1930, a total of cover 19,000 ha had been planted. In 1932-33, changes in plantation policy resulted from findings that the danger from bee hole borer was three times as serious in plantation as in natural forests and that it was not profitable to grow timber in plantations for export. The government thus ordered to plant teak and xylia Kerri only for domestic use and not for export.

However, in 1937-38 the government again revised the policy to increase the establishment of plantations to 600 ha per annum. That was again checked during World War II and gathered momentum again only in 1963. Up to that period, only a few thousand hectares of manageable plantations were established annually. These plantations were formed more on a compensatory nature in scattered small plots of approximately to (20) ha. They were treated as natural forest after attaining the age of 40 years.

Extensive forest plantations in large blocks were formed commencing from 1972, and further large-scale plantation programme was launched starting from 1980. It started with a target of 16,190 ha annually. It reached a peak of 36,340 ha in 1985. However, this was considered to be 100 ambitious and unmanageable and currently is limited to 32,380 per annum. A total of 543288 has had been planted up to 1995.

4.3.3 Bamboo Resources

Bamboo grows abundantly through out the country either mixed with tree species or in the pure stands. Pure stands of Kanyin-wa (mellocanna bambusoides) stretch over and area of about 8,000 sq.km on the Rakhine mountain range with an estimated growing stock of 21 million metric tons. Taninthayi division also contains pure stands of WA-ya (oystermanthera nigrocilliata) over an area of some 1800 sq.km with estimated growing stock of 6 million tons. The bamboos in the Bago Division are of mixed -forest type and
consists of a number of different species of which Kyathaung-wa (Bambusa polymorphia), Thait-wa (caphalostchynper grauel) and Myin-wa (dendrocalamus stratus) are commercially important of the 96 known species of bamboo only about 13 species are considered commercially important so far.

4.3.4 Mangrove Forests Resource

Myanmar has more than 2000 km of coast line along the Bay of Bengal that comprise the Rakhine, Ayeyawady delta and Taninthayi regions, the pattern of land use in the coastal areas consists of mangroves, coral reefs, see grass beds, evergreen forests and water lands, settlement and various types of agricultural land. The areas contribute to maintaining biological resources which are significant for the country's economy, and for the conservation of biological diversity.

Mangroves are found in all three regions. The delta formation is the most extensive one, which is situated at the Southern most portions in the Ayeyawady Delta. Another two formations are found along the sheltered coasts in Rakhine and Taninthayi regions. The mangroves of the Ayeyawady comprise about 29 species and represent the most complex and variable vegetation found among the mangroves of the Asian region. Wildlife in the Delta currently consists of a unique mixture of marine and land fauna and they owe their existence to the plant communities and ecosystems that give them shelter. There are 65 species of fishes, 13 species of prawn, 4 species of crabs, 9 species of shell fishes, mussel, and oyster inhabiting in delta. In addition, there are 6 species of mammals, and over 30 species of birds.

Mangroves in Myanmar are of interest to conservationists because of the unique life forms that live among them and the adaptation of mangroves themselves. However, most of the extensive mangroves in the Ayeyawady delta are much degraded because of exploitation for fuel wood and charcoal production.
4.3.5 Biodiversity status

Myanmar is often cited as the last frontier of species recorded for plant life and 1071 are endemic. It also has a rich wildlife resource, which includes over 1000 species of birds, more than 300 species of mammals and 700 species of reptiles and amphibians. Out of these, species such as the Asian elephant, tiger, thamin deer, Ayeyawady dolphin, gaur and four species of marine turtles are included in the list of globally endangered species.

Four hundred birds' species, mammals, hooded tree pie, white-browed nuthatch, white-throated babbler, and Myanmar yuhina are endemic. Myanmar also has the most diverse snake fauna in the old world tropics. The country has 68 swallowtail butterflies so far recorded and ranks fifth in the in this respect. However, 45 species of mammals, 39-species of birds, and 36 species of reptiles in Myanmar have been listed as endangered.

4.4 Fishery sector and Marine resources

The fisheries sector is considerably important in Myanmar's economy, as fish constitutes a major source for animal protein in the diet of the people. Myanmar has an abundance of rivers and streams, a long coastline and a large mangrove area in the delta region. An area of about 486,000 sq.km in the coastal regions has been demarcated as an economic zone for fisheries. The country also has an ocean area of about 163,000 sq.km, which is suitable for trawling.

Types of fishery in Myanmar are determined by nature of catch. Fresh Water Fisheries consist of (a) fish culture, (b) leasable fisheries, and (c) open fisheries. Marine Fisheries include (a) in-shore fishery and (b) offshore fishery. Freshwater fisheries are mainly of the nature of flood fisheries made possible through vast river systems and heavy rainfall. There are also leasable fisheries, which cover a vast area. Fish culture operations are at the same time undertaken extensively in ponds, lakes, and reservoirs.
Fresh-water fishing is made up of pond and river (leasehold) fisheries, both conducted by the private and State sectors, and open and flood fisheries conducted by the private sector. The total catch appears to have expanded since 1988, although seasonal fluctuations make it difficult to assess trends.

Myanmar is so rich in fresh water fish, marine fish and prawn that maximum catch, without deteriorating fishery resources, amounts to 1.5 million metric tons per annum. Area for fresh water culture in natural lakes, ponds, streams, canals, tanks and dams is estimated to be about 8.2 million hectares. Production on fish and prawn from 3474 lakes in Myanmar has been 68,000 tons annually. Water body of 41 dams, with a total area of 80,000 hectares serves as rich resources for fishery. Tidal forest of 6 million hectares at the mouth of three main rivers plays as breeding ground for fresh fish and prawn for a period of half a year. The country is endowed with rich and varied marine and inland fishery resources, with a production potential (sustainable yield) of 1.05 million metric tons per annum from marine source alone. Inland water bodies such as natural lakes, reservoirs, river systems ponds etc. cover an area of about 8.2 million hectares.

To overview the Marine fisheries, the Union of Myanmar enacted the "Territorial Sea And Maritime Zone Law" on 9 April 1977 and the law clearly defined the Baselines (straight lines drawn between fixed points on the mainland, on islands or rocks officially recognized by Myanmar as its territory. Schedules of such points are indicated in the Law). The Territorial Sea extends twelve nautical miles from the baselines. The Continental Shelf (extending two hundred nautical miles from the baselines) and the Exclusive Economic Zone in which the zone area covers a distance of two hundred nautical miles from the baselines.

Myanmar has a long coastline of 2832 kilometers. The total area of swamps along the coast is about 0.5 million hectares which provides a very good basis for the
development of shrimps and prawn culture. The continental shelf (shallow coastal area) covers 228,781 sq kilometers and Myanmar's Exclusive Economic Zone (E.E.Z) is 486,000 sq. kilometers wide. According to surveys and research undertaken in marine fisheries, the Maximum Sustainable Yield (MSY) of the Union of Myanmar is estimated at about 1.05 million metric tons per year. It is promulgated that Myanmar Special Economic Zone for Marine Fishing is demarcated from base line to 2000 nautical mile Private Sector, Cooperatives and joint ventures actively participate in fishery business while State supervises only model Fish and Prawn Farms and hatcheries. With an aim to develop the private sector, State owned fishing vessels, ice plants and cold storage facilities are hired or sold out to the private entrepreneurs.

Along with coasts, local fishermen still practice the "drift net" and "trammel net" methods for harvesting near-shore fish. Even so, in accordance with government regulations and guidelines, only officially prescribed nets are permitted for catching a particular kind of fish. Regarding fishing vessels, vessels of a maximum 30-foot in length with 6 horsepower engines are allowed to operate close to the coast while larger vessels must operate at 5-10 miles from the shore, thus preventing over harvesting of near-shore reef fish resources.

In 1988-89 Fiscal years, the export of fish and prawns earned US$ 10 million. However, in 1998-99 fiscal years, it earned US$ 201.33 million and the amount of US$60.78 million was earned from the period between 1 April 1999 and 28 September 1999. In the year 1999-2000 fiscal years from all the states and divisions, the production of Prawn by nature of catch is shown in the (Table 4.8).

Aquaculture played a minor role in Myanmar's fisheries industry till 1989. Only three thousand hectares of fishponds were established at the time. However, due to the encouragement and support by the government through the law relating to aquaculture, the aquaculture industry has now expanded to over ninety thousand acres of fishponds. The Government of Myanmar has thus encouraged the expansion of aquaculture through
proper management so as not to cause environmental degradation. Intensive breeding, improper use of chemicals, destruction of mangroves and other fish habitats, discharge of untreated wastes etc. are considered grave offences, and are dealt with accordingly.

**Table 4.8** Production of Fish and Prawn by nature of catch in Myanmar
(Thousands in Viss)

<table>
<thead>
<tr>
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<td>55798</td>
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<td></td>
<td>Leasable fisheries</td>
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<td>41539</td>
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<td>262676</td>
<td>293085</td>
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<td>528519</td>
<td>558555</td>
<td>618841</td>
<td>713669</td>
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</tbody>
</table>


At present, only fourteen percent of the total production could be exported due to insufficient number of processing facilities, ice plants, cold stores etc. Although the government still manages some demonstration farms and hatcheries for extension service, the main infrastructures in the fishery industries are managed and operated by private entrepreneurs. In other words, there is no State owned institution competing with the private sector in fishery and fishery related operations. There are about (646) species of fish in Myanmar's Marine Fishery Waters and most of the exported products come from this source.
Section 2

4. 5 Environmental problems of Myanmar

The following section reviews the major environmental problems in Myanmar.

4.5.1 Environmental issues relating to land and water resources

Environmental issues of Myanmar can be studied under two broad categories, land, and water. The land related environmental issues could further be bifurcated into problems of low and high agricultural production potential areas.

4.5.1.1 Low Production Potential Areas and Environmental Issues

Low Production Potential Area (LPPA) is the mountainous region of Shan plateau and arid and semi-arid regions. The LPPA occupy about 97 % of the land area, whereas only 51% (21.1) million people of the total population live there and only about 51% of the present cultivable area is located in this area. The LPPA accounts for only 32% of the total rice area of the country and produces about 27% of the total rice production. Among the LPPA, the arid and semi-arid region is the most favourable area for crop production development. The Shan plateau has medium favourability and the mountainous region is the least favourable. Therefore, the LPPA are subdivided into L1, L2, L3 depending upon their topography, climate and soils (Tha Tun, Oo, 1999 ),(see Fig 4.3).

(a) The Steeply Sloping Area (LI) and environmental problems

The Chin Hills, Northern Ranges, bordering China, and India, leeward side of the western mountain ranges and eastern Dawna mountain ranges, bordering Thailand are included in the LI area. The elevation ranges from 700m to 2000-3000m above sea level and the mountains are steep and highly dissected with gradients of 45% to 70%. The atmospheric temperature is usually chilly and the annual rainfall is 2000-2500mm. The Mountainous Red Brown and Yellow Brown forest soils (Cambisols) are the dominant soils of this area. They are acidic and low in fertility the high gradient and the shallowness of soils make the area very unfavourable for intensive annual crop
Figure A3: Land classification due to soil capacity of Myanmar
cultivation. Soil erosion and landslides are common hazards of this area.

The LI occupies about 40% (27.28 million ha) of the country but it is sparsely populated. Kachin, Kayin, and Chin are the major races of the area totaling about 2.74 million people or 6.6% of the total population. The people are simple and not very ambitious. They cultivate only 5.31% of the whole rice area and produce very low rice yields per acre. Therefore the area is not self-sufficient in rice for local consumption.

In this area, shifting cultivation is the major hazard detrimental to the environmental sustainability. There are about 71.69% ha of shifting cultivation land planted with rice and other domestic crops annually. This is equal to 22% of the total shifting cultivation area of the country. The shifting cultivation area and the upland area are 17% and 5% respectively of the totally sown LI (Low Production Potential Area). These areas are cultivated with upland rice; other cereals and food crops in the rainy season and left bare the rest of the year. There are also more than 100,000 ha of annual fallow land. All these lands are prone to yearly water erosion. The increasing population pressure will make the shifting cultivation area increase and the fallow land areas bigger, causing more deforestation and soil erosion.

Deforestation in this area was mainly caused by slash and burning for shifting cultivation. Appraisal by the forest department in 1989 stated that total forest areas affected by shifting cultivation by the Kachin, Kayin and Chin states, were 16.66%, 61.30%, 69.15% respectively. The data indicates the serious state of deforestation, and the accompanying land degradation and ecological destruction.

(b) Rolling and Undulating Upland Area (L2) and environmental problems

The Shan plateau region is designated as L2 (Rolling and Undulating Upland Areas) area, which is border China, Laos and Thailand in the eastern part of the country. This area totals 19.14 million ha and occupies 28.2% of the total land area of the country. L2 has distinct physical features of tableland like topography. The tableland rises
abruptly from near sea level in central Myanmar from 650 to 1200m above sea level in the Shan and Kayah States in the east. This region is well known as the Shan plateau and is famous for its pleasant climate and scenic beauties. The average altitude is about 1000 m above sea level but is varied due to the rolling and undulating topography. The eastern most borderline mountain range can be as high as 2000 meters and above.

The most dominant and agriculturally important soils are the red earths (oxisols/ferralsols), which are also known as Terra-Rosa, red lateritic soils or simply red soil. The soils are acidic and low in fertility due to the removal of topsoil and bases by surface water erosion and leaching. But the texture is loamy and easy to work. The profile development is deep and water absorption is good. The soil is almost devoid of organic matter. It is very responsive to liming fertilization.

The Shan and Kayah groups are the major occupants of this area, though there are many different minorities. The total population of L2 is 4.43 million, which is about 11% of the total population of Myanmar. The population density is much less than that of Myanmar as a whole. The people are very simple and unambitious. These factors are taken into consideration in the planning of area development.

**Shifting Cultivation** is also the major cause of environmental deterioration in this area. More than 100,000 ha or over 32% of the total annual shifting cultivation area of the country is found in this region. More than 16% of the total sum area in L2 is annually under shifting cultivation. More shifting cultivation is practiced in L2 than other parts of the country because many different minor races are scattered over the mountains which are not very steep like those of LI and hence it is easier to slash and burn.

Upland cultivation plays an important role in the development of agriculture of L2. Over 35% of the annual agriculture upland crops such as upland rice, maize, soybeans, vegetables and cash crops occupy the area. There are more than 360,000 of annual fallow land. Almost all of these areas are covered with crops or weeds only in the
rainy season and left bare to the sun and wind in the rest of the year. Not only the topographical nature of L2 is favourable for water erosion, but also the light texture soils, which are devoid of cementing agents like organic matter, are favourable for wind erosion too.

In this area the main cause of **land degradation** is shifting cultivation, which is causing accelerated erosion. The slash and burning exposes the soils to sheet and gully erosion and the wrong agronomic practices such as cultivation against the slopes cause rill erosion. Therefore, slight to severe soil erosion is found in almost all the upland and has resulted in the gradual decline of crop yields which in term leads to more deforestation and slash and burning by the local farmers to produce enough food for their mere survival. In this way a chain reaction on the environmental destruction continues.

It has been universally accepted that deforestation and slash and burning cause serious losses not only of timber species, but also other rare flora and fauna. Myanmar is no exception. But no firm data can be cited here about the ecological and genetic deterioration due to deforestation and slash and burning in Myanmar. Moreover, it can be said for sure that the ecological losses will be great because L2 is topographically and climatically unique in Myanmar and is the home for rare flora and fauna.

(c) **Arid and Semi-Arid Area or L3 area and environmental problems**

The lower part of the Sagaing division and the whole of Mandalay and Magway divisions are included in L3 (Arid and Semi-arid Areas). This region is known as the dry zone of Myanmar. The L3 occupies about 19 million ha or 28% of the country. This region is included in the low production potential areas due to its arid climate and unreliable rainfall, but agriculturally L3 is the second most important area of Myanmar except for paddy.
The L3 occupies the upper part of Ayeyawady alluvial plain and the elevation ranges generally from 0-250 m above sea level. The peripheral areas are foothills of pre-mountain ranges of LI and L2, and the central part is usually level or slightly undulating. The area has the highest maximum temperature from 105' F to HOT and lowest annual rainfall from 750 mm to 1000 mm. Therefore more than 75% of the total irrigated area of Myanmar is found in this region.

There are two main soil types namely, red brown Savannah soils (luvisols) and dark compact soils (vertisols) which are agriculturally important soils of Myanmar after the paddy soil (gleysols). The low and level areas re-occupied by the vertisols and the higher periphery, gently sloping and undulating areas are occupied by the luvisols. The soils have neutral to alkaline reactions. The vertisols are dark in colour and characteristically high in clay content whereas the luvisols are reddish brown in colour and have more than 65% of sand. The two contrasting characteristics of the soils give the region the agricultural capability of growing different low land and dry land crops such as rice, wheat, groundnut, sesame, sunflower, cotton, pulses, and beans.

The total population of the region is estimated to be 14 million or 33% of the population of Myanmar. Majority of the population are Burmese with a few minorities. The people are industrious, ambitious, and intelligent. A majority of the population are well-established farmers since the region has a history of ancient Myanmar Kings. Impressive irrigation systems initiated by these kings are still functioning in these areas.

Only 14% of the total shifting cultivation area, i.e., about 46,000 ha is under shifting cultivation in L3 and is practiced only on the higher periphery of L3 which are foot hills and pre-mountains of the LI and L2 areas. This shifting cultivation area makes up only 1.5% of the total cultivated land area of L3, whereas the upland crops area occupies 64%. About 22% of the total low land rice area and about 87% of the total upland and dry land cropping areas of Myanmar are found in L3. More than 75% of the total irrigated area is concentrated in this region. Therefore, area-wise shifting cultivation
does not seem to be harmful, but since many irrigation dams and canals are situated in this area, there is a costly danger of siltation of the irrigation systems due to the soil erosion from upper shifting cultivation areas. Moreover, a high average of upland and dry land cropping within the area is also subjected to wind and water erosion because, although the uplands of this area are not highly sloppy like in L2, they are still susceptible to both types of erosion, having 3-10% slopes, rolling and undulating topography and light sandy texture. Since this area has a high potential for future agriculture development, minor consideration must be given to the environmental sustainability of this region.

The main cause of deforestation in this area is woodcutting and charcoal making. There is a common belief that the central dry zone was once a thickly forested area; but due to the heavy woodcutting for brick making to construct numerous Pagodas during the time of ancient Myanmar kings, the area was gradually turned into semi-desert like conditions. The forest department (1989) appraised that the L3 area has 68,444 km2 of closed forest, 18,344 km2 of degraded forest and the forest affected with 25-75% shifting cultivation was 27,207 km2 or about 24% of the total forest area of L3.

Myanmar as a whole has 24.3% of non-forested land whereas this L3 area has more than 37% of non-forested land. This figure indicates the extent of deforestation for dwellings and cultivation purposes. Other statistics shows that the quality of the forest is also degrading due to human influences, and aridity of climate. From 1975-89, the closed forest areas have decreased in Mandalay and Magway divisions, except in the Sagaing division. Even the degraded forest areas have declined to give way to upland crops and shifting cultivation. The population pressure on this area can cause further destruction of forests and its quality.

**Land degradation** is the most serious problem of this area. As mentioned earlier, there are two agriculturally important soil types in L3, namely Iuvisols, vertisols. Both soils are subjected to land degradation of one form or another. The Iuvisols, which
occupy the upper periphery and rolling and undulating topography, with light texture and loose structure, suffer from both wind and water erosion. The luvisols are completely devoid of organic matter for cementing soil particles, which are easily blown away during summer windstorms. Water erosion damages soil with gentle slopes on rolling and undulating topography during the rainy season. Therefore, coarse layers are exposed in most of the luvisols of this region, negatively affecting the crop production.

On the other hand, the heavy clay low land vertisols are affected by salinity and acidity due to saline and sodic irrigation water on one hand and bad drainage and salt accumulation by the water flow down from the upper periphery, on the other hand. In this way the soils of L3 are degrading due to the reduction in soil depth, fertility, moisture holding capacity and productivity. Genetic erosion in this area is occurred but no statistics are available to present the facts and figures. However, circumstantial evidence indicates that there were woodlands in this area, which were a sanctuary for endemic flora and fauna.

Thus, it is clear that the most affected environmental problems of L1, L2, and L3 areas are deforestation and land degradation by shifting cultivation and woodcutting for fuel.

4.5.1.2 High Production Potential Areas (HPPA) and Environmental issues

The high Production Potential area (HPPA) consists of Ayeyawady delta region, the coastal strips, and the central plain regions. The HPPA occupy only about 3% (2.14 million ha) of the total land area of the country. However, over 49% of the total population of Myanmar inhabit in these areas. The HPPA has more than 49% (4.05% million ha) of the total arable and permanent cropped land areas of Myanmar. These areas account for more than 68% of the total rice land and about 74% of the total rice harvest of Myanmar. Industrial raw materials like jute and rubber are exclusively grown in this area. Therefore, the HPPA is extremely important agriculturally and economically.

The central alluvial plain and the Ayeyawady Delta regions are generally level plains with a few high altitude spots such as Bago mountain range. The coastal strips
have level topography extending towards the sea, whereas the western parts are hilly due to the descending foothills of the western and Dawna Mountain Ranges.

The coastal strips receive the heaviest rainfall (3750-5000 mm) in Myanmar. The Delta and the central plain region also receive a high quantity of annual rainfall ranging from 2000-2500 mm. Supported by the flat terrain and heavy clay soils, the HPPA has become the most important rainfed lowland rice growing area known as the "Rice bowl of Myanmar".

The soils are predominantly Meadow Gley (Gleyic Cambisols) and alluvial soils (fluvisols). Small areas of yellow brown lateritic soils (Latosols/Cambisols) are found on the foothills and pre-mountain areas of the central strips. Meadow gley soils are well developed and have heavy clay textures with a high water retention capacity and low infiltration rate. These soils are slightly acidic and low to moderately fertile. The alluvial soils are better drained, more fertile and possess silty clay loam textures. Both soils are good paddy soils with a high potential for increasing cropping intensities if supplemented irrigation is provided. The soils are also responsive to heavy fertilization.

The yellow brown lateritic soils are found in the small area with hilly and undulating topography. They are acidic in reaction, heavy in texture, low infertility and suitable for orchards, garden and plantation crops. More than 65% of the garden and plantation crops of the country are located in this region. Since 49% of the total population, i.e., over 20 million people live in this HPPA area which covers only 2.14 million ha, the population density is 10 people/ha, which is much higher than that of LPPA. About 80% of the population is ethnic Bamar and the rest are Rakhine and Mon. All those occupants are intelligent, ambitious, and competitive people. Agriculture in this area is well developed and the farmers are very responsive to modern technologies and land and water development. Erosion hazards are very low because shifting cultivation is negligible except in some areas at the foot of the western and Dawna mountain ranges, but this region has a different set of environmental problems.
(a) Water logging and Salinity

Water logging and flooding are two harmful phenomena affecting the sustainable agricultural development of this area. The HPPA is often hit by the annual tropical storms, especially in the coastal and delta region. Inadequate draining systems and silted waterways due to the soil erosion of the upper LPPA makes this low land area waterlogged and inundated. Delay in sowing of crops due to water logging, in undulation and annual flooding reduces due to the water logging, in undulation and annual flooding reduces the crop yields considerably. In some areas, no crops can be grown at all during the rainy season due to the stagnation of water. Water logging and flooding not only reduces agricultural activities, but also cause the spread of water borne diseases among the population of the surrounding areas. The average of surface water irrigation in this area is negligible and there is no ground water irrigation here. Therefore, there are no dangers of acidity and ground water salinization in HPPA. But salinization due to flooding and seawater encroachment is a problem in this area. Many areas along the coastal regions and low-lying delta regions are subjected to annual tidal water encroachment - causing soil salinization. Though severity of the salinity is not very pronounced during the rainy season in which rather salt tolerant rice crops are grown. The salinity effects appear greater after the rain stops, and a second crop is almost impossible in this salt affected area.

(b) Hazards of Monoculture

The HPPA is essentially a mono-cropping rice cultivation area. Even after the introduction of High Yield Varieties (HYV) which gives more time for second cropping, the average cropping intensity of this area still remains at 11.3%, which is much lower than the national average cropping intensity of 12.5%. The main reasons for low cropping intensity in this area are heavy rains and lack of irrigation. During the rainy season only rice is favourable while in the dry season there is lack of moisture for the second crops. The present main second crop is jute, which is grown by pump irrigation. The benefit of rice mono cropping of this area is food sufficiency for the country and promotion of rice export to earn foreign currency. But there are environmental hazards as well in this monoculture. There are the dangers of spread of insects, pest and disease which can
thrive year after year on the same crop plant, especially HYV, the deterioration of soil structure due to the prolonged submergence; reduction of iron and manganese which are toxic to plants; the rise of ground water table; and the depletion of the same type of nutrients from the soil nutrient reserves year after year, contributing to nutrient imbalances.

(c) Fertilizer Imbalances

All the arable and permanently cropped soils are generally deficient in available N and P, while K was sufficient to maintain the modest yields of traditional crop varieties. However, with the introduction of modern high yielding varieties and increasing cropping intensities, the soil reserves of plant nutrients are rapidly depleted, especially in this area in which high yielding varieties replaced 40-60% of the traditional rice varieties. The fact is that the introduction of short duration HIV's made it possible to increase rice-based double cropping, which removes additional soil nutrient reserves.

The Union of Myanmar average rice yield from 1940-1970 was 1.67 metric tons per hectare. The fertilizer use was mainly farmyard manure (FYM). However, with the introduction of HIV's. better techniques and increased inputs of chemical fertilizers and insecticides, rice yields increase to 2-3 metric tons per hectare, during the year 1970-1985. However, supplemental fertilizer nutrition is very low being only 20-34 kg/ha so as to be insufficient to replenish the nutrient removal by the crops. Micronutrients were never used commercially in Myanmar agriculture. Therefore, environmental pollution due to excess use of chemical fertilizers will not pose a problem in Myanmar in the near future. On the contrary, the environmental hazard is the excess removal of soil nutrients and inadequate replenishment of them.

Another problem is the imbalanced application of chemical fertilizers. In 1987-88 crop seasons, 202815 tons of chemical fertilizers were used to grow 11-53 million acres of rice. The ratios of the applied fertilizers were 80:14:6 for urea, TSP and MOP respectively. But the farmers are very willing to apply urea because the immediate
response of urea application can be seen by the instant green colouring of plants. But the
farmers are reluctant to use phosphorous and potash fertilizers whose effects are not
immediately observable on the plants. Therefore, the long-term application of imbalanced
chemical fertilizers can cause a serious nutrient imbalance in the soils, which can lead to
soil deterioration and reduce crop production.

The soil micronutrient problems are not extensively investigated yet; but it can be
said for sure that Myanmar soils are definitely deficient in microelement such as zinc and
sulphur, as some experiments indicated crop response to Zn and Sulphur applications.
The above facts indicate that nutrient imbalance exists and needs to be corrected
immediately; otherwise it will lead to environment deterioration of the arable lands.

4.6.1.3 Strategies for Sustainability in the Low Production Potential Areas

It is evident from the above that shifting cultivation and land degradation are the
two main causes of environmental deterioration and low crop production of the (LPPA)
low production potential areas. Shifting cultivation is the main cause of deforestation,
which in turn leads to accelerated soil erosion and land degradation in the LI and L2
areas. However, shifting cultivation is only partly responsible for the environmental
degradation of the L3. The land degradation due to wind and water erosion, and
salinization and alkaiinization are the main cause of environmental degradation of L3.
Therefore, the strategies for the sustainability of environment and agriculture of the
LPPA must be based upon the different local conditions. The following measures are
being taken at the macro and micro levels to promote sustainable and environmentally
sound land and water development in the LPPA.

(i). Firstly, the shifting cultivation areas and the deforested areas were surveyed and
recorded by the forest department and land records department, while the saline and
alkaline areas were surveyed and identified by the land Use Division of Myanmar
agriculture service.
(ii) Once those areas were identified and extents of damage were known, then the
departments concerned undertook the approximate measures. Research and experiments
were conducted as required.

(iii) The Forest Department is preventing further deforestation by educating the villagers concerned about the laws and liabilities of indiscriminate woodcutting and forest burning, and has introduced reforestation with the participation of the surrounding villagers and Taung-ya (shifting cultivation) system, which can benefit both the farmers and the department.

(iv) The land records department is responsible for recording the success or failure of various cropping areas including shifting cultivation.

(v) Myanmar Agriculture Service is educating the villagers through extension agents about the demerits of shifting cultivation and also demonstrates the construction of bench terraces, contour bands and advises an appropriate hillside farming methods such as valley cropping, strip cropping, etc.

(vi) The Land Use Division has conducted experiments to find out suitable methods of land reclamation and soil amendment for the saline and acidic soils and demonstrated and advised the farmers on the use of appropriate technologies.

Many departmental activities have been going on for a long time on the preservation of the environment at micro levels in agricultural, industrial and health sectors; but the following initiatives will be pursued more energetically to stimulate environmental awareness at grass root levels:

(i) Education of hill and upland farmers about the detrimental effects on the environment of slash and burning and deforestation;

(ii) Practical demonstration of the causes and effect of accelerated soil erosion to the fanners.

(iii) Preventive measure of soil erosion and land degradation and appropriate hillside and upland farming technologies will be transferred to the farmers through training and group discussions.

4.5.1.4 Strategies for Sustainability in High Production Potential Area

It is evident that HPPA is endowed with vast extents of leveling land, which is not susceptible to wind and water erosion. The area is gifted with better soils and abundant
rainfall, which makes this area the rice bowl of Myanmar. This area possesses about 50% of the current arable and permanently cropped land of Myanmar and has potential for future agriculture expansion.

However, the environmental hazards such as water logging, nutrient imbalances, monoculture, and misuses of pesticides need to be controlled for environmental and agricultural sustainability. The following measures are being taken at macro and micro levels to promote sustainable and environmentally sound land and water development,

(i) The irrigation department increased the flood protection area from 1.8 million metric acres in 1961-62 to 2.652 million metric acres in 1989-90. Drainage facilities were increased from 1.8 million acres in 1961-62 to 4.79 million acres in 1989-90.

(ii) The Myanmar Agricultural Services is investigating the salinity problems of the area, researching soil ameliorative methods and introducing salt tolerant HYV rice varieties.

(iii) The Myanmar Agriculture Service is undertaking soil testing and soil-crop-fertilizer research on the farmers’ fields to determine the soil nutrient status and balanced fertilizer norms for rice.

(iv) The Myanmar Agriculture Service built a new pesticide plant in upper Myanmar in 1988 and is producing neem pesticides at an increasing annual rate. The farmers are welcoming these products. Therefore, there is a great potential for the increased production of neem extracts, which can replace a large portion of toxic chemicals in plant protection.

(v) The Myanmar Agriculture Service is importing less harmful and toxic pesticides and encouraging their use only at the economic threshold levels, which can be determined by scouting methods.

(vi) The Government of Myanmar has recently enacted a pesticide law and agriculture agents are training and educating the farmers as well as the pesticide retailers on the correct handling and usage of pesticides.

(vii) The Myanmar Agriculture Service demonstrated and encouraged rice farmers to grow rice-based and second crops such as jute, groundnut, sunflower and sesame, either with the residual moisture or by pump irrigation from numerous fresh water rivers and streams in the delta. Thereby, the farmers can earn more money and the adverse effects of
rice monoculture are reduced.

To stimulate environmental awareness and existing and potential means for monitoring social and environmental consequences for high production potential areas are largely the same as described for low production potential areas in the previous section. At the macro level, however, the Myanmar Agriculture Service, Irrigation Department, and Fisheries Department will increase their efforts to educate both farmers and fishermen about environmental destruction caused by logging, soil salinization, nutrient imbalance, monocropping and misuse of pesticides.

4.5.2 Other Major Environmental Problems in Myanmar
4.5.2.1 Soil Resources and their Problems

There are about 24 soil types in Myanmar, which are dictated by soil-forming factors such as rainfall, parent rocks, and topography and landforms. However, only three main soil groups are recognized as agriculturally important; alluvial, black and red laterite soils. The alluvial soil makes up some 50 per cent of the total sown area and is located in river basins and the delta. Black soil occurs in about 30 per cent of the area and is generally found in the dry zone region, while red laterite soil accounts for 20 per cent of the area and is found in lower Myanmar associated with undulating topography.

Problem soils are characterized by soil and agro-climatic constraints to sustainable agricultural production, limiting the range of crops that can be grown successfully. In Myanmar, problem soils occupy an area of nearly 1 million ha, representing about 7.8 per cent of the total cultivable land. Of the area of problem soils, about 68.75 per cent (660,000 ha) comprises saline and alkaline soils, although most of them are current under cultivation. The remaining problem soil area comprises acid sulphate, degraded, peat, and swampy soils. Therefore saline and alkaline soils are the predominant problem soils in Myanmar. In the hilly region and the central plains of Myanmar gradual degradation of soil fertility is occurring through erosion. However, the worst affected region is the dry zone, which covers Mandalay, Sagaing, and Magway Divisions. The depletion of natural resources is a matter of concern, as is the wasteful
destruction of forests through shifting cultivation, with its wind and sheet erosion. In the hilly regions, wind and sheet erosion and gradual desertification in the semi-arid zones are cases in point.

Steps needed to be taken to introduce and enforce terraced cropping or stripped cropping with appropriate forest belts in between, in lieu of shifting cultivation, in the hilly regions. In some parts of the hilly regions of the Chin and Shan States traditional shifting land use practices have resulted in continuous soil degradation, making the land less suitable for economic crop production. In order to avoid the recurrence of such problems, steps are being taken to promote terrace cultivation and conservation farming methods in those areas. The Inlay Lake has become shallower because of the soil erosion in watershed area, loss of vegetation cover, and unfavourable agricultural practices such as slash and burn cultivation and shifting cultivation. Similar phenomenon is found in the dry zone area of central Myanmar. Similarly, extensive wind belts, associated with suitable cropping pattern in the dry zone, need to be established to minimize soil losses and halt desertification. For the development of soil-depleted areas, measure will be taken to prevent further deterioration of hitherto eroded and fertility depleted fallow sloping

### 4.5.2.2 Impact of fertilizers and pesticides on environment

Concern over environmental damage has assumed global dimensions and Myanmar cannot remain divorced from stark realities. However, because of budgetary and foreign exchange constraints, the sum total of pesticide and fertilizer use does not meet the actual requirement, which may be a blessing in disguise. As yet, pollution and contamination are not grave problems in Myanmar. The utilization of pesticides and fertilizers is very low compared to neighbouring countries. In fact, of the 23 in the Asia-Pacific region, Myanmar is among the 10 countries, which have the lowest fertilizer consumption in terms of nutrients (1990-91 figures).
Being a developing agricultural country, at least for the foreseeable future, Myanmar will inevitably use pesticides in agricultural food production, although other parallel efforts of non-chemical nature are being investigated in plant protection strategies. The most practical way to handle the pest problem is the use of chemicals with intelligent concern and proper control. However, recent data indicates the need for cautious control through coordination and cooperation between government agencies and with the people themselves. In addition, agricultural pesticide use in the country is expected to increase with the abrupt change of cropping pattern aimed at increase in rice production and the expansion of various crop-growing areas.

The quantity of pesticides imported by semi-government organizations and NGOs has been growing in recent years. In the near future the proportion of imports by private organizations may dominate as a result of government policy to encourage the private sector while the government concentrates on technical and legislative measures.

The Ministry of Agriculture has a pilot pesticides formulation plant for which technical grade materials are imported and pesticides produced. The plant extract insecticide is produced by the ministry's pilot neem pesticide plan. Insecticide from the neem tree is effective against many leaf-eating caterpillars but has little or no toxic affect on humans or the environment.

For the purpose of scrutinizing the efficacy of pesticides to be approved for use, minimizing hazards to human health and environment promoting safe and effective use of pesticides and assurance of registration, the government formed the Pesticide Registration Board in 1992. The Board is entrusted to implement the Pesticide Law with the following objectives:
(a) The registration of all pesticides before marketing;
(b) The control of pesticide use on food and environment;
(c) The control of pesticide production distribution and disposal etc;
(d) Monitoring the quality of pesticides in use; and
The control of residues in food and the environment.

So far, no national standards for pesticide residues have been established. Since Myanmar has encountered some pesticide residues in food from international trade, it is essential to set maximum residue limits and legally control them. The ratio of samples violating the Codex Maximum Residue Limits (Codex MRL) and National MRL (export requirement), based on the number of samples analyzed by the Pesticide Analytical Laboratory in recent years is quite significant.

The commodities analyzed were mainly means for export and the residues exceeding the limits were mostly the result of post-harvest application of improper pesticides such as Aldrin and DDT. The national export requirements are generally lower than the codex MRL. The current use of persistent pesticides will affect the residual levels in food through plant uptake for many years. Some organo-phosphorous insecticides were also detected. In addition, residues from the incorrect use of post-harvest pesticides, e.g., aluminum phosphate, still remain to be examined.

The use of pesticides had started in Myanmar only in the 60’s and the amount of their use is relatively very low. Since then the import and distribution is solely done by the concerned agency of the Government. Although Myanmar has a total crop sown area of about 9 million hectares, the annual import of pesticides remained low at about 800 metric tons, but in some years, it rose up to 1000 metric tons to 1900 metric tons, as pests and diseases outbreaks have been low. However, it is expected that pesticides utilization will definitely increase in the future, as Myanmar gets more and more into producing high quality agriculture produce and crop intensification.

Though the pesticide usage quantity of Myanmar is still being under the danger level, the mode of utilization is important. Some farmers have very little knowledge of pesticides and are using them indiscriminately, not only killing the targeted pests and insects, but also the beneficial insects, soil micro organisms and natural predators.
Incorrect method of spraying, timing and washing of the spray equipments has contaminated the rural lakes, ponds, and rivers causing direct affects to the onsite fish and farmers. Offsite effects also can be found in the downstream areas. Indirect effects are also found upon wildlife and surrounding people who consume the contaminated water, fish, and vegetables. Another defect caused by the incorrect usage of pesticides is the development of more resistant insects and pests. They become more tolerant to the frequently used pesticides. The pesticides become totally ineffective or stronger and higher dosages are needed which are more harmful to the environment and the people. To solve this problem, the Government of Myanmar has recently enacted a pesticide law and the agriculture agents are training and educating the farmers as well as the pesticide retailers on the correct handling and usage of pesticides.

The use of organic chlorine pesticides has already been banned, but they are still used for vector control because alternative measures cost high. A thousand tons of pesticides are used for agriculture and sanitation control for these 10 years. The problems are contamination of natural resources and food with the persistent pesticides and illegal traffic of pesticides from border regions.

4.5.2.3 Marine Resources degradation and coastal degradation

The coastline of Myanmar, from the Naff estuary of Rakhine State to Kaw Thong of Taninthayi Division is about 1,800 kilometers. When the coastlines of gulfs and islands are included the coastline totals nearly 3,000 kilometers, of which about 230,000 sq.km in area is suitable for marine fishing.

The sea area of Myanmar is estimated to contain a standing stock of 1.7 million tons of pelagic and demersal fish, of which about 1 million tons comprise the maximum sustainable yield (i.e. can be caught without diminishing the original stock). Since the total fish and prawn catch in 1994-95 was only 600,000 tons, it is obvious that as far as marine fishing is concerned there is no over exploitation; thus there is no danger of depleting the marine resources at the present rate of production. One support piece of evidence that the current marine catch per hour of 200 kg is unchanged from that
recorded over the past 15-20 years. Foreign fishing and joint venture company vessels are allowed to fish only outside the continental shelf and fees are imposed in accordance with GRT. Those measures also help to prevent overexploitation of marine resources.

(a) Coastal Erosion and Sedimentation

Myanmar has 410,000 ha of mangrove areas along its coastline, which are being systematically preserved. The marine forests furnish protection from natural disasters such as storms, tidal waves, and floods while catching the silt from rivers and streams thus minimizing erosion. Since there are very few factories, mineral mines or wharves along the coast of Myanmar there is no natural sedimentation yet, and since the coastal aquaculture industry is still using the tradition "trap and hold" method, sedimentation is not a threat.

(b) Reef Degradation and Eutrophication

Along the coasts, mangrove forests as well as reefs are important habitats for marine fauna. The existence of coral reefs also prevents erosion, as do the mangrove forests; old and traditional methods are still largely practiced in catching fish and prawn along the reef. Since methods such as dredging and the utilization of specific poisons and bombs are not commonly practiced yet, reef degradation and eutrophication are not a danger at present (Thein.M, 2000).

4.5.2.4 Mangrove Forest Degradation

The original area of mangrove forests in Myanmar was 953.641 acres (385933 ha) in early 1990. Due to over exploitation for firewood and charcoal and the excessive expansion of agriculture land, half of the mangroves area has been depleted during the last decades. Bio-fuel is the major source of energy in Myanmar. Approximately, 27 million air-dries ton (ADT) of biofuel, 61% of total energy consumption of the country is consumed annually. The trend of wood fuel consumption and the net surplus, deficiency in Ayeyawady Delta for 1990, 2000, and 2005 (in million ADT) are shown in (Table 4.9) below:
Table 4.9 The trend of wood fuel consumption and the net surplus /deficiency in Ayeyawady Division for 1990, 2000 and 2005 (in million ADT)

<table>
<thead>
<tr>
<th>year</th>
<th>Sustained yield woodfuels</th>
<th>Local Consumption</th>
<th>Export</th>
<th>Import</th>
<th>Surplus/Deficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>0.59</td>
<td>3.99</td>
<td>1.22</td>
<td>0.10</td>
<td>-3.83*</td>
</tr>
<tr>
<td>2000</td>
<td>0.86</td>
<td>4.51</td>
<td>1.00</td>
<td>0.30</td>
<td>-4.35**</td>
</tr>
<tr>
<td>2005</td>
<td>0.59</td>
<td>4.71</td>
<td>1.00</td>
<td>0.30</td>
<td>-4.82**</td>
</tr>
</tbody>
</table>

** Project figure

Myanmar forests in Bogalay, Laputla, and Maulamyaing kyun of Ayeyawady Forest Division have been managed systematically since the early twentieth century. These mangrove ecosystems are fragile but essential to support the sustained production of fisheries and inland rice cultivation. They provide the coastal dwellers with shelter, protection from the ravages of severe winds and with timber for domestic uses, fuel wood, charcoal, and many other forest products.

To meet the needs for fuel wood, charcoal and other forest product, these mangrove forests have been exploited beyond their capacity. Large parts of reserved forests in Ayeyawady delta, except Meinmahlatkyum wildlife sanctuary, have been degraded, deforested, and mostly depleted due to excessive fuel wood /charcoal production and paddy field encroachment.

These tidal forests (mangroves), according to 1942 estimates, covered 671492 acres as shown in the (Table 4.10). Due to the ever increasing demand for firewood and charcoal by Yangon city and for various forms of forest product, produced by the local population, the 1990 estimate, indicate that mangrove forest have been reduced to
438,000 acres. Mangrove forests in the delta had been excessively exploited and eventually turned into agricultural lands. According to 1950 assessments the mangrove forests have been undergoing depletion at a rate 2.4 times higher than that of the depletion of forests in the country, which highlights the need to urgently implement management strategies for the mangrove ecosystems. Table (4.10) shows the assessment of Ayeyawady mangrove forest area from Aerial photo Interpretation and Landsat Imagery. Though appropriate measures have been taken to protect the mangroves in the delta, at present, due to increases in population as in table (4.11) and excessive needs for fuel, most of the mangroves, which were out of reach of the forest department staff, have been heavily encroached.

Table 4.10  Ayeyawady mangrove forest cover assessment from API & Landsat Imagery
(Area in Acres)

<table>
<thead>
<tr>
<th>No.</th>
<th>Township</th>
<th>Mangrove Area (Acre)</th>
<th>1942</th>
<th>1954</th>
<th>1984</th>
<th>1995</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bogalay</td>
<td></td>
<td>373,685</td>
<td>100%</td>
<td>316,632</td>
<td>84.73%</td>
</tr>
<tr>
<td>2</td>
<td>Laputta</td>
<td></td>
<td>251,102</td>
<td>100%</td>
<td>217,858</td>
<td>86.76%</td>
</tr>
<tr>
<td>3</td>
<td>Maulamein kyun</td>
<td></td>
<td>46705</td>
<td>100%</td>
<td>44,997</td>
<td>96.34%</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td>671492</td>
<td>100%</td>
<td>579,487</td>
<td>86.30%</td>
</tr>
</tbody>
</table>

Source: (1) Forest Department NFMI Project, MYA/88/008 Da’aqor 1924 to 1984

Table 4.11  Townships population in Ayeyawady mangrove areas from 1931-1993

<table>
<thead>
<tr>
<th>Sr.No</th>
<th>Township</th>
<th>1931</th>
<th>1953</th>
<th>1983</th>
<th>1993</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bogalay</td>
<td>8074</td>
<td>23211</td>
<td>294225</td>
<td>353419</td>
</tr>
<tr>
<td>2</td>
<td>Laputta</td>
<td>-</td>
<td>12843</td>
<td>238516</td>
<td>262393</td>
</tr>
<tr>
<td>3</td>
<td>Maulameingyun</td>
<td>7747</td>
<td>16464</td>
<td>-</td>
<td>271008</td>
</tr>
</tbody>
</table>

Source: Manpower and Immigration Dept, Ayeyawady Division, Pathein, 1995.

The government, in 1993, stopped extraction of all forests of produce from
mangrove forests and extensive replanting and protective measures have been taken. As a result regeneration is apparent in some areas. Due to excessive pressure on delta forests for the supply fuel wood and charcoal and the extension paddy cultivation, the forest area in Laputta, Bogalay and Maulamyaing Kyun has reduced substantially as shown in Table 4.1 respectively. The forest cover in Laputta is 6.6%, 16.11% in Bogalay and almost nil in Maulamyaing kyun, against 62.5% in 1925 in these townships. Ayeyawady mangrove forests have been seriously degraded and it could affect the mangrove ecosystem. If the mangrove ecosystem is unbalanced, a scarcity of forest produce, Salinization of paddy fields, erosion of riverbanks, decreasing number of fish and prawns will follow and the consequences will bring a severely damaged natural environment and food scarcity.

The following facts can be considered as the main cause of degradation of Ayeyawady mangrove forest:
(a) Although the mangroves had been managed systematically prior to the Second World War, some of them became a refuge of the insurgents after the war, and effective management was not possible.
(b) As the resettlement of villages was legally permitted in the mangrove-reserved forests around 1960, management of forest resources was weakened.
(c) There was over exploitation of firewood and charcoal to meet the demands of Yangon city and the local community. Until 1993, about 400,000 tons of firewood and charcoal was produced annually to meet this demand.
(d) With the assistance of the World Bank, a large area of mangroves was converted to paddy fields in the 1970's.
(e) Inability of working plan renewal resulted in the inability of applying the plan after the 1970's.
(f) Township - level management occurred after the district - level management ceased in the 1980's.
(g) The migrants encroached in the demarcated forest reserves for firewood and they gradually grew rice there.
(h) The illegally reclaimed paddy fields of the migrants were later occupied by wealthy persons from other areas and small villages were formed. Along with rise in agricultural
and fishery business, 18879 acres were depleted and transformed into paddy fields.

(i) Land, food, poles, and firewood were abundant and easily accessible in the reserved mangroves areas at all times.

(j) Mangroves were assumed to be common property resources and illegally settled on a first come first served basis.

(k) After the prohibition of the commercial production of firewood and charcoal commencing from 1993, meeting the local requirement became an important issue. For the consumption of the urban and rural communities of Ayeyawady delta area, 300,000 tons of firewood is needed annually. Inevitably, the illegal exploitation of mangroves increased (Tun Paw Oo.U, 1993)

4.5.2.5 Water Related Problems

Myanmar is rich in water resources. Estimated run-off is 180.5 billion m$^3$ per year in normal year, only 5% or 55 billion m$^3$ is utilized for irrigation and drinking water. Potential for water resource development is high. As population grows, water demand increases and it leads to extraction of groundwater. At present ground water is extracted from shallow aquifer without any bacterial inspection. This might cause sanitary problems. Groundwater sanitation should be managed. Besides unrestricted extraction of groundwater might lead ground subsidence and salinization which should be prevented by proper management. There is no specific agency, which has the budgetary mandate of authority to have initiatives of water resource management.

The Inlay Lake has become shallower because of the soil erosion in watershed area, loss of vegetation cover, and unfavourable agricultural practices such as slash and burn cultivation and shifting cultivation. Similar phenomenon is found in the Dry Zone area of central Myanmar. Traditional water management system can no longer meet the requirements of the market economy. Reform of the water resource management system and strengthening of the relevant authorities' capabilities are required. Insufficient information and data on water resources are also of the obstacles.
According to the 1995 survey, drinking water supply coverage was 60% nationally and 50% in rural areas. The low access, particularly in the rural areas, requires water collectors who are mostly women and girls to walk long distance to safe water sources. Use of even safe drinking water in bad sanitary situation contributes high incidence of infectious diarrhea, especially among children under 5 years old.

Rainfall in Dry Zone of central Myanmar is less than 1000 m, where water is extracted from the deep well with hand or motor pumps. Provision of drinking water from mini-irrigation system has also been attempted in some areas. In south Myanmar, shallow dug wells as well as tube-wells are used. In the coastal area where the groundwater is salinized, rainwater collection system is used. In hilly areas, natural spring are tapped and piped down to communities. Water supply system in Yangon can not guarantee the water quality good for drinking, as existing water treatment facility is incapable. The second reason is that there is a military industry using lead beside the water reservoirs in Gyobyu or Phugyi.

There are more than 300 towns in the country, most of which still lack of sanitary water supply system. Schools offer sanitary education, which contributes dissemination of idea on safe water and sanitation. It is expected that 100% coverage of safe water supply will be achieved by 2005. However, insufficient budget and inadequate priority of the sector may be constraints. Further, though many authorities share the responsibility of water supply, National Water and Sanitation Committee takes the initiative (JICA, 1999).

4.5.2.6 Pollution Problems

There's some air pollution in Yangon city by vehicle emission gas, but the extent of the pollution is not yet described although Japan International Cooperation Agency (JICA) technical operation was initiated in 1999-2000 in order to introduce air pollution monitoring technique to Myanmar. Neither laws nor standards are established for air quality control. The organization in charge of air pollution prevention is not defined.
(a) Waste Management

In Myanmar, a large number of industries and factories are located in the vicinity of cities like Yangon and Mandalay. But some large-scale light and heavy industries have been established in different parts of the country. Most processing plants are located in close proximity to the sources of raw materials. Rice mills are found along the riverbanks in the rice-growing delta. A large number of factories and plants have also been built along the Ayeyawady River. However, the level of industrialization is relatively low and as a result, the extent of industrial pollution is minimal and no major pollution hazards due to industrial wastes have been experienced in the country. The Myanmar Investment Commission has issued guidelines whereby all projects established with the permission of the Commission shall be responsible for the preservation of the environment at and around the project site. The enterprises are duly responsible to control the pollution of air, water and land and other environmental production matters. Moreover according to the Factories Act, effective arrangements are required to be made in every factory for the disposal of its waste and wastewater effluents. In Myanmar, most of the large industrial plants have their own on-site treatment systems for controlling pollution due to the disposal of industrial wastes.

The Development Committee undertakes wastewater and Solid waste management in most of the towns and cities in Myanmar. The villages in the rural areas with respect to their waste disposal system are mostly supervised by the Health Department. The wastewater and solid waste management in Yangon consists mainly of the collection and disposal system, which comes under the responsibility of the Yangon City Development Committee (YCDC). Plans are underway to upgrade these systems in the immediate future.

Myanmar has several legal frameworks and legislations dealing with environmental protection of which water pollution, solid and air pollution are some of its key components. But they are difficult to enforce unless a certain degree of penalty is
meted out to the offenders. Moreover since the environmental standards are still lacking effective control to protect the environmental cannot be undertaken yet. Presently, authorities responsible for environmental affairs are formulating measures to establish National Environmental Standards, which are crucial component in the environmental management programme. The plan for improvement of solid waste management drawn in 1980 presented the development of 13 sites of landfill and employment of waste collection by containers. A pilot study was conducted under the plan, but the whole plan is still not implemented.

Collection coverage of household waste is estimated to be 25% compared to the generation quantity. A collection vehicle rings the bell to draw attention and the inhabitants throw their waste into the vehicle. The collected waste is disposed in the dumpsites located in sub-urban area. Stabilized waste from these sites are offered free of charge to the public for use as compost in home garden and in the creation parks and gardens in the city. Municipal workers and scavengers salvage useful material at communal street dumps or dumpsites and sell it to allied cottage industries.

Paper mills, leather tanning factories and textile factories discharge toxic and hazardous industrial waste. It is necessary to watch it because the waste amount will increase as the economy grows (JICA, 1999).

(b) Industrial Waste Water

The government has taken water treatment measures for the state factories such as paper mills, textile mills with bleaching and dyeing process, tapioca starch factories, and breweries. Examples of water pollutions are Sittoung paper mill, which destroyed the aquatic life in Sittoung river and Kyunchaung fertilizer plant, which discharged arsenic, used in its process to the Ayeyawady river. Myanmar's investment Commission has issued s notification in June 1994, requiring all permitted enterprises to install wastewater treatment plants and other pollution control facilities to be able to comply with the sanitary and hygienic regulations.
Neither institutions for water pollution control nor the effluent standards have been established. Ministry of Labor is responsible for inspection and reporting on wastewater under the factories Act. Yangon City Development Committee and Mandalay City Development Committee is responsible for water pollution control in their city areas.

The degree of air or water pollution caused by industry or agriculture has been minimal due to the still low level of industrialization and relatively small amount of chemicals used in agriculture. However industrial expansion is expected in the near future owing to the recent change in the country's economic policy that will increase involvement of the private sector and foreign investments in its economic and industrial activities. Growing use of chemicals is however to be expected in agriculture.

4.6 Environmental Conservation and Management in Myanmar

Environmental considerations are not yet fully incorporated into the national development plans. This is partly due to the fact that the over all environmental condition is still satisfactory and do not necessitate immediate environmental protection measures. However, Myanmar's consciousness over nature conservation dates back many years ago. Historical records show that environmental conservation and protection works were initiated since the last dynasties of Burmese kings during which teak (Tectona grandis) trees were declared as royal property and royalties were levied for extraction (Brandis, 1896). Forests were reserved as sanctuaries where catching, hunting, killing, or harming of birds and animals were strictly prohibited. However, the concept behind the conservation of wildlife then, was basically religious and was not the conservation of biodiversity in modern sense. The Myanmar kings also undertook protection of teak forests. The systematic management of forests started only in 1856, when Dr. Dietrich Brandis was given charge of the Bago forest (Blandford 1956; Forest Department of Myanmar, 1989; Stebbing, 1947). Following the early in 1857, new rules were published, bringing the Bago forests under regular conservancy and controlling the removal of teak trees. Soon after this, Brandis drew up the first working plans for Bago teak forests. The
plans were drawn based on ring counting and observation of trees of known age. He calculated that it took 24 years for trees between 45 cm dbh (4'6" gbh) to 60 cm dbh (6'6" gbh) to become yield trees of 60 cm dbh (girth 6' 0") and over. Accordingly he described that 1/124th of the number of yield trees should be cut annually. Brandis estimated the number of yield trees for Bago forests from linear valuation survey. This silvicultural system, which forms the basis for the present management method, was known as the Brandis Selected System and was maintained for many years. The original Brandis Selected System was modified into the Myanmar Selected System in 1920, is still in use up to the present time. This system is merely a selection-cum-improvement system with the main features being to carefully protect the immature stock and assist it to attain maturity (Blanford, 1956). This improvement felling consists of thinning in immature teak, removal of certain proportion of silviculturally undesirable mature trees, opening up of patches of established and advance growth, climber cuttings, removal of inferior growth suppressing teak and its valuable associates, and cutting of dead and moribund trees (Kermode, 1957). Instead of 24 years of felling cycle, Myanmar increased 6 years, thus, making felling cycle into 30 years and the management system was also renamed as "Myanmar Selected system".

At present, Myanmar's environmental management pattern is largely sectoral. For instance, the Ministry of Forestry is responsible for sustainable forest management including wildlife conservation, while the Ministry of Industry controls and regulates industrial activities and pollution. The Ministry of Health is responsible for environmental-related health issues. The Ministry of Livestock, Breeding, and Fisheries carry out conservation of marine and fresh water fishery resources. There has been a growing awareness of the environment among the public authorities in Myanmar especially in the past decade. The National Commission for Environmental Affairs (NCEA) was established in 1990. It serves as the national focal point and coordinating agency on environmental matters.
The (NCEA) as the focal point and coordinating agency is responsible for coordinating environmental programs, plans and projects of both publish and private sectors. However due to financial, technical and manpower constraints, the (NCEA) can not fully carry out its mandates and responsibilities. Moreover to ensure sound and effective environmental planning and management information on existing environmental situations is required. The establishment of the environmental Databases Unit in NCEA only began in April 1994 and at present the collection of environmental data and information on a nation wide scale has not yet been undertaken.

With the rise in environmental awareness, presently, more and more government ministries and departments are incorporating environmental considerations in their plans and projects and are involved in environmental related activities in some ways. The general public is also becoming more involved in environmental protection and conservation measures.

The Union of Myanmar presently has 46 legal instruments relating to environmental protection. Various government ministries and departments administer these laws. The important environmental related laws include the Pesticide Law (1990) which monitors and controls the selection, storage, transportation and use of pesticides to protect people, crops, other biological entities and the environment; The Myanmar Marine Fisheries Law (1990) which lays down regulations to protect the marine fisheries; The Myanmar Tourism Law (1993) which aims to preserve and develop historical sites, monuments, natural scenic beauty, natural environmental heritage and traditional art and customs of national races ; The Forest Law (1992) which aims to implement the forest policy and environmental conservation policy of the Government and the Protection of Wild Life and Wild Plants and Conservation of Natural Areas Law (1994) which aims to protect wild life and wild plants and to conserve the national areas of the Government. The Factories Act has provision whereby effective arrangements are required to be made in every factory for the disposal of wastes and waste water effluents. In Myanmar, most of the large industrial plants usually have their own methods of treating wastewater and
controlling air pollution.

4.6.1 National Environment Policy

The National Environment Policy of Myanmar believes in "the wealth of a nation is its people, its cultural heritage, its environment and natural resources. The objective of Myanmar's environment policy is aimed at achieving the integration of environmental considerations into the development processes to enhance the quantity of the life of all its citizens, every nation has the sovereign right to utilize its natural resources in accordance with the environmental policies, but great care must be taken not to exceed its jurisdiction of infringing upon the interests of other nations. It is the responsibility of the state and every citizen to preserve its natural resources in the interest or present and future generations. Environmental protection should always be the primary objective in seeking development". In the draft of the state constitution, "environment" means "natural environment". It states, "The state shall protect the natural environment".

Myanmar Agenda 21 was prepared as an environmental action plan as well as the following environmental policy. The NCEA Commission has competency over all environmental matters and will be responsible directly to the Cabinet Internationally the NCEA will act as a focal point with government bodies and international organizations. In the following section the national forest and marine policies are discussed, each of them has impact on environment.

4.6.2 Myanmar Forest Policy

Since Myanmar had been a province of India under the British Rule, the 1894 Indian Forest policy had guided the forest management in Myanmar for many years. In the face of a dynamic population and a rapidly changing socio-economic and political environment there was a need for an explicit forest policy to address the change. It had also been recognized that the new policy interventions were needed for calibrating a fit between forest plans and programmes, the forest resource base and the people. The need for ensuring ecological balance, environmental stability and enhancing the contribution
of the forestry sector towards socio-economic development of Myanmar in a sustainable manner was also eminent.

In view of the importance of the Myanmar forestry sector in enhancing national socio-economic development and ensuring ecological balance and environmental stability the Myanmar Forest Policy (1995) has been formulated in a holistic and balanced manner within the overall context of the environment and sustainable development taking full cognizance of the forestry principles adopted at UNCED. It formalized the commitment and intent of the Government to ensure sustainable development of forest resources while conserving wildlife, plants and ecosystems.

The forest through increased productivity while controlling the socio-economically the policy has identified six imperatives that the Government must give the highest priority in order to achieve broader national goals and objectives. These are:

(a) Protection of soil, water, wildlife, biodiversity and environment;

(b) Sustainability of forest resources to ensure perpetual supply of both tangible and intangible benefits accrued from the forests for the present and future generations;

(c) Basic needs of people for fuel, food and recreation;

(d) Efficiency to harness, in the socio-environmentally friendly manner and the full economic potential of the forest resources;

(e) Participation of the people in the conservation and utilization of the forests; and the socio-economic development of the nation.

(f) Public awareness about the vital role of the forests in the will being and socio economic development of the nation.
According to the imperatives, the policy has focused on the protection of soils, water catchments, ecosystems, biodiversity, genetic resources, scenic reserves and national heritage sites, on the sustainable forest management to ensure in perpetuity the level of benefits both tangible and intangible for the present and future generations, on providing the basic needs such as fuel, water, fodder, shelter, food and recreation, on the efficiency in harnessing the full economic potential of and environmentally unacceptable side effects, on the people's participation in forestry, wildlife and nature conservation activities and in establishing plantations and increasing non farm incomes by applying community and agro forestry systems, and on raising awareness of the decision-maker and politicians in national socio-economic development, bio-diversity, soil and water conservation and environmental stability essential for sustained life on earth.

The forest policy aims at a balanced and complimentary land use, gazeting 30% of the total land area as reserved forest and 5% as protected area systems, encouraging participatory forestry, making EIA of development projects obligatory, intensification of silviculture and management, promotion of non-wood forest products and private investment in wood-based industry, encouraging down stream wood processing and use of under-utilized species, phasing out gradually of round log export, and strengthening forestry research, training and institution in both quantitative and qualitative terms.

The Burma Forest Act 1902, with amendment made from time to time, had been in use up till the new forest legislation, Forest law 1992, was promulgated by the State Law and Order Restoration Council in November 1992. The new forest law, in line with the Myanmar Forest Policy, focuses on the balanced approach towards conservation and development issues implicit in the concept of sustainable forestry. It decentralizes the management and opens up opportunities for increased private sector involvement in timber trade. Highlighting environmental and biodiversity conservation, the law encourages community forestry and people's participation in forest management to meet the basic needs of the rural people, but prescribes severe punishments for forest offences. In addition, the Ministry of Forest (MOF) has promulgated the Forest Rules in 1995.
In conformity with the new Forest Policy and Legislation, and for the purposes of gaining environmental stability and addressing basic needs of local communities, active participation by the rural population is urgently needed to plant trees in barren lands and to reforest degraded areas. To achieve these goals "Community Forestry Instructions" are issued by the Forest Departments prior to the formal enactment of the Community Forestry Rules.

The Community Forestry Instruction, 1995 is a comprehensive and liberal legal framework to promote community participation in forestry. It defines Community Forestry as the "reforestation of areas insufficient in wood fuel and other forest products for community use" and for the "planting of trees and extraction and utilization of forest products to obtain food supplies, consumer products and income" by local community participation. The features of the instructions are that existing reserved forest and government plantations can also be alienated as community forests; that procedures to apply for community forests are simple; that it is mandatory to prepare a management plan before handing over the forest to community; that certificates are issued by the Forest Department (FD) to the user groups; that substantial inputs are provided by FD; that responsibilities and duties of user groups are transparent; and that provision made for prohibitions, harvesting of forest products, pricing selling, taxation, and transportation are reasonable.

In order to promote and facilitate community participation in managing the forests, the Director-General of the FD had issued a significant statement of "Community Forestry Instructions" in late 1995, focusing on management of forests by rural communities through protection of natural vegetation, establishment of forest nurseries and forest plantations so as to enable them to fulfill their own basic needs for firewood, farm implements and small timbers. The Community Forestry Instruction clearly demonstrates the sharing of forest management responsibilities towards the rural communities through user groups' activities and efforts with in-kind and technical assistance from the FD. It also focuses on the flow of benefits to the communities,
participating in forest management activities. The duration of lease of land for the establishment of Community Forest is set initially for 30 years and it is extendible depending on the performance and desire of the user's group.

As clarified by the major activities mentioned, forest resources of Myanmar are being managed towards sustainable development within the context of security of resource base, production, conservation of biodiversity, replenishment of renewable resources, and social and cultural dimension. Under-utilized or Less-used timber species are to be evaluated and introduced to both domestic and world markets. With regard to the promotion of less-used species utilization and markets, efforts are being undertaken in many ways, i.e. through research and development, activity programme and internationally funded projects.

So far, only teak and few hardwood species are harvested at commercial level and many of the non-teak hardwoods are virtually untapped from the point of commercialization. Even large tracts of bamboo resources are still poorly tapped for commercialization. Forestry sector is now providing enough room for the expansion of private sector and international entrepreneurship to fully utilize these under-tapped forest resources.

The deltaic and coastal mangroves are the important breeding grounds for aquatic species. They engaged fishing industries and provide the local people with food, shelter, small timber, fuel wood and other forest products. Myanmar has more than 2000 km coastal line and mangroves are found in three regions, namely Rakhine, Ayeyawady Delta and Taninthayi with coverage if some 785,00 ha of which 320,106 ha are reserved forest. These mangroves are primary source of biofuel, sawn timber, ports, and poles for local people. They also serve as essential breeding and feeding grounds for diverse species. However, due to over explorations of mangrove forests for firewood and subsistence forming, deforestation and degradation of mangroves have been taking place, particular like Ayeyawady delta and Rakhine.
As of 1999-2000, some 100,000 ha of mangrove forest have been given effective protection, about 10,203 ha of forest plantation were established, and more than 4454 ha of community owned multi-purpose plantations have been formed. In addition, 13,715 improved cooking stoves were distributed to save wood fuel consumption.

4.6.3 Suggested Policies for the Promotion of Sustainable Development in the Forestry Sector

The following suggested policies are proposed by the State:

(a) Forest Inventory

In order to ensure availability of up-to-date information on national forest cover, a forest inventory should be taken regularly; using satellite imagery, the geographical information system and aerial photography followed by statistically and biologically sound ground checks. The inventory must include, the location, topography, type of forests, tree species and, if possible, some parameters for estimating the age of trees so that the value of forest products can be appraised at the time of the inventory. Such data are valuable in checking whether or not illegal timber extraction is taking place.

(b) Forest Protection

Existing forests need to be guarded and protected from various forms of destruction, be it ecological or mechanical and especially from illegal loggers and poachers. Access routes by land or sea must be blocked and regularly checked.

(c) Securing high productivity from use of agricultural and forest land

Areas requiring urgent action to contain adverse impacts on forests include the adoption of improved technology to secure high productivity from agricultural and forest land, combined with a careful assessment of land potential to permit allocation for the most appropriate use. Investments in research, training and the dissemination of necessary technology are required to ensure optimum, together with adjustments in policy and planning in order to support implementation. A fundamental requirement
is the awareness, commitment and full participation of the *de facto* decision-makers, i.e., the population and communities involved in forestry and agriculture.

(a) Social forestry

Apart from the long-term benefits of eco-restoration, including soil and water conservation, the immediate benefits of forestation are substantial in terms of generating employment and providing fuel and fodder. In addition to State and Division schemes for social forestry, the centrally sponsored schemes of social forestry such as the greening of nine districts in the central dry zone of Myanmar and village fuel wood plantations should be extended to cover all fuel wood deficit areas. Special attention should be given to the identification and propagation of indigenous, location-specific and thermal-efficient species that are acceptable to the people. Efforts must also be made to bring down the unit cost of afforestation and to secure wide participation by the population. Forest management should be made more sensitive the aspirations and needs of the public.

(b) Coordination and cooperation between the agricultural and forestry sectors

The agriculture and forestry sectors should coordinate and cooperate closely in various tasks including, proper land-use planning, construction of dams, watershed management and catchments area control, preventing siltation and sedimentation of reservoirs, coping with submerged trees in new irrigation projects and Sloping Agricultural Land Technology (SALT). SALT is an excellent example of where agriculture and forestry programmes combined symbiotically to form a replicable model. SALT is a well-known soil conservation-oriented farming system developed in the Philippines in the late 1970s. The agro forestry technology of SALT has gained Asian-wide popularity as a culturally appropriate, ecologically fit, economically sound and technically a cute development tool. SALT should be introduced as an effective substitute system in slash-and-burn areas. SALT technology will complement government policy on the development of border areas and ethnic groups as well as secure the border regions.
(c) Land-use Policy

Encroachment into tropical forest areas is the result of population pressure, which results in the need to expand agricultural land. The problem calls for a land use policy to oversee and coordinate overall land utilization in the country. It is necessary to prepare a land-use plan, which should ensure that land is used for the purpose for which it is best suited. The most important issue is to ensure that the total land area of Myanmar is used prudently and effectively as that will ultimately lead to socio-economic development in an environmentally friendly way.

(d) Shifting cultivation

The problem of shifting cultivation has long been a focus of attention among administrators, foresters, agronomists and diverse specialists. With the application of SALT, about 2 million roving farm families who cultivate an area of about 2,430,000 ha, which mainly comprises un-classed and degraded forestland, can settle down in locations of their choice. Through SALT they can enjoy farm produce as well as forest products. However, the rapidly growing population has resulted in a major increase in the frequency with which shifting cultivation blocks are being cultivated that has led to changes in the vegetation. Consequently, serious efforts should be made to establish a well-defined tenure system to serve as an incentive for shifting cultivators to improve the productivity of the land. All available means should be employed through education and training of farmers to promote the use of permanent and modern agricultural systems (Thein, M, 1998).

4.7 Two Sustainable Initiatives

4.7.1 Development of Ayeyawady Mangrove Project

Due to the serious and alarming effects of depletion of mangroves, which constituted about 46% of Myanmar mangrove resources, the Government of Myanmar requested international assistance to redress the growing wood fuel supply demand imbalance in the Ayeyawady delta and to develop the planting technology needed to rehabilitate degraded and denuded areas to conserve the mangrove environment and enhance its protective and productive functions. The Mangrove Reforestation Project
(MYA/90/003) was carried out from March 1991 to December 1993. The continuation of the project, the Community Development of Ayeyawady Mangroves project (MYA1931 026) was from February 1994 to December 1995. Community Development of Ayeyawady Mangroves was continued for three years (1996 to 1998) as Project (MYA/99/008) adding a new Township Maulamyang Kyun to the original Bogalay and Latputta Townships. All three Townships are considered most critical for rehabilitation of the Ayeyawady Mangroves.

The objective of the development project is to promote sustainable human development by improving the socio-economic welfare of disadvantaged communities in critical areas in the coastal Ayeyawady delta, through mangrove environmental regeneration, protection, improved fisheries, income generation and sufficiency in wood fuel and wood products. The three immediate objectives of the project are: (1) strengthening rural capacity in planning and implementing mangrove protection and conservation to improve sustainable fisheries and wood fuel supplies; (2) improving mangrove protection conservation, wood fuel supply demand balance and estuarine fisheries in selected villages to achieve sustainable supply-demand balance; and (3) improving rural capacity to undertake and manage income generating activities based on mangrove land and water resources.

Villages practicing mainly agriculture, forestry, fishery and a combination of these were selected as project villages. Community development works were emphasized in these villages. Sixteen villages from eight village tracts were selected in Latputta Township. Thirty-two villages from eight village tracts were selected for Bogalay Township, totaling forty-eight project villages altogether. In Bogalay Township, mainly agricultural villages were located as a cluster very close to town.

The immediate Project Activities are: (1) 2400 acres of mangrove plantations in the forest reserves, 1000 acres of mangrove forests to be naturally improved by RTF (Regeneration Improvement Felling) method, (3) Development of village owned
Forest Resource and Environmental Development Association (FREDA), with the financial assistance of Action for Mangrove Reforestation, Japan (ACTMANG), and Japan International Cooperation Agency (JICA) had launched a programme to reforest 500 ha of Mangrove plantations within 5 years (1999-2003) in the southern portion of Pyindaye reserve forest, Bogalay Township. Concerned efforts of FREDA project staff in collaboration with the FD of Bogalay Township and the community participation enabled them to establish 346 ha of mangrove plantation up to July 2001. The project, thus, comes to 4 years instead of 5(1999-2002).

During the year 1999, FREDA has purchased several thousand seedlings (about 150,000) from the FD nursery at Byonhmwe for planting of 130 acres (52.5 ha). However, during the year 2000, adequate number of seedlings could be produced from Oakpo-kwinchaung for planting of 350 acres (141.5 ha). In 2001, both Oakpo-kwinchaung and Wagon nurseries have capacity to produce 720,000 seedlings to plant 375 acres (152ha). FREDA is now establishing 2 more nurseries one at Kanyingon and the other at Khakyin, so as to save time for transporting seedlings to the planting sites in the year 2000. Out of 350 acres in 2000 and 375 acres (year 2001) of plantations area the Regeneration Improvement Felling (RIF) areas of 75 acres and 100 areas is included (see Table 4.11.a). The RIF operations is carried out to improve the degraded natural mangroves were regenerated and promising seedling and sapling growth need to be released from the over head cover. Enrichment planting is carried out in the gaps in the RIF areas. Total plantation including enrichment planting and RIF areas for 3 years are presented in the Table 4.11.a and Plantation Establishment in 2002 is shown in table 4.11.b).
Table 4.11.a  Plantation Establishment during 3 years

<table>
<thead>
<tr>
<th>Sr.No</th>
<th>Year</th>
<th>Plantation area (acres)</th>
<th>RIF area (acres)</th>
<th>Total area (acres)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1999</td>
<td>130</td>
<td>-</td>
<td>130</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>2000</td>
<td>275</td>
<td>75</td>
<td>350</td>
<td>Included 50% enrichment</td>
</tr>
<tr>
<td>3</td>
<td>2001</td>
<td>275</td>
<td>100</td>
<td>375</td>
<td>Planting in the RIF areas</td>
</tr>
<tr>
<td></td>
<td></td>
<td>680</td>
<td>175</td>
<td>855</td>
<td></td>
</tr>
</tbody>
</table>

*Source: Ohn, U, Mangrove Project, 2002.*

Table 4.11.b  Plantation Establishment in the year 2002

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Name of village</th>
<th>User group members</th>
<th>Planting area in acres</th>
<th>Natural RIF area in acres</th>
<th>Total area in acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Oakpo-kwin Chaung</td>
<td>35</td>
<td>25</td>
<td></td>
<td>25</td>
</tr>
<tr>
<td>2</td>
<td>Tebin Seik</td>
<td>18</td>
<td>25</td>
<td>-</td>
<td>25</td>
</tr>
<tr>
<td>3</td>
<td>Wagon</td>
<td>42</td>
<td>30</td>
<td>20</td>
<td>50</td>
</tr>
<tr>
<td>4</td>
<td>Kanyingon</td>
<td>71</td>
<td>120</td>
<td>30</td>
<td>150</td>
</tr>
<tr>
<td>5</td>
<td>Khakyin</td>
<td>22</td>
<td>40</td>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td>6</td>
<td>Kywe Te</td>
<td>38</td>
<td>30</td>
<td>20</td>
<td>50</td>
</tr>
<tr>
<td>7</td>
<td>Ma HmweKwin</td>
<td>27</td>
<td>30</td>
<td>20</td>
<td>50</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>253</td>
<td>300</td>
<td>100</td>
<td>400</td>
</tr>
</tbody>
</table>

*Source: Ohn, U, Mangrove Project, 2002.*

Not only the reforestation of mangroves, the study on marine life and their relationship with mangrove system is already started and local cottage industry level livestock farming, environmentally friendly fish and prawn culture, charcoal burning and wood vinegar collection, sewing and weaving for the women and handicraft making from various mangrove species are the future development programmes in the project area.

ACTMANG also distributed nitrogen fixing and soil improving plant species to improve the unproductive and abandoned fallow lands to become productive again.
Project personnel in collaboration with the ACTMANG team are conducting several research programmes such as soil and water quality analysis, relationship between mangrove and marine life, and the community development and participation in restoring mangrove ecosystem (Htein Lin, "Saving the Mangroves in the Ayeyawady Delta", The Late Friday News, 98th edition, 2002).

4.7.2 Desertification and the Dry Zone Greening project

In Myanmar due to its better rainfall, desertification is a recent problem and is localized to the Central Dry Zone Area. This area is a region affected by droughts in the last few decades and combined with loss of vegetation cover; the conditions are ripe for the spread of desertification. To counter the threat of desertification the Dry Zone Greening project was initiated.

Even before Myanmar became a party to the United Nations Convention to Combat Desertification (UNCCD), greening of the arid zone has always occupied a place of priority in Myanmar environmental protection endeavours. After Myanmar became a party to the Convention, these efforts have been further enhanced with the establishment of the Dry Zone Greening Department in 1997. This department together with the Myanmar Agriculture Service, Irrigation Department and Water Resources Utilization Department of the Ministry of Agriculture and Irrigation act as the principal implementing agencies.

Among the measures taken by the Government to combat desertification, "Greening Project for the Dry Zone" is significant and most effective. The Greening Project is being implemented by the Dry Zone Greening Department. The Dry Zone Greening Department was entrusted with the following objectives:

1. To green the Central Dry Zone of Myanmar;
2. To protect and conserve the environment as a whole, and land and water resources in particular;
3. To provide the basic needs for forest products of the rural people;
(4) To enhance the socio-economic development of rural people on a sustainable basis;

(5) To raise local people's awareness of the value and beneficial effects of forest and trees;

(6) To enhance knowledge and promote participation of the public on environmental conservation and sustainable development;

(7) To improve micro-climate conditions of the environment so as to support sustainable productivity of agriculture; and

(8) To prevent desertification.

There were major four main tasks to be implemented, which had been set up by the Dry Zone Greening Department: (a) Establishment of forest plantations; (b) Protection and rehabilitation of remaining natural forests; (c) Initiating development and utilization of wood fuel substitutes; and (d) Development of water resources.

(a) Establishment of Forest Plantations

Prior to DZGD, the Forest Department has been establishing forest plantations in deforested areas to restore forest cover and to rehabilitate environment. Up to 1997/98, a total of 72,210 acres (29,233 ha) had been planted under the Nine Districts Greening project. In 1998/99, DZGD planted a total of 35,287 acres (14,280 ha) comprising 18,280 acres (7,398 ha) of village forests, 8,920 acres (3,610 ha) of watershed plantations, 2,900 acres (1,174 ha) to green mountains, 137 acres (55 ha) for research purpose and 5,050 acres (2,044 ha) of wood lots.

In 1999/2000, DZGD planted a total of 35,040 acres comprising 13,257 acres of village forest, 14,700 acres of watershed plantations, 2,700 acres to green mountains, 133 acres for research purpose and 4,250 acres of wood lots. (Reports, DZGD, 2000).

(b) Protection of Natural Forests

About 1.82 million acres of degraded forests and about 2.8 million acres of forest affected by shifting cultivation have been identified as existing in the Dry Zone. Protection against human, cattle and fire has been found to be very effective in improving
degraded forests. Degraded forests considered to be capable of improving naturally are, therefore, identified, demarcated and protected. Constant patrols are being made by forest guards permanently stationed along the borders. Silvicultural treatments such as weeding, cleaning, climber cutting, thinning and coppicing are provided where necessary, in order to accelerate natural growth while fire lines and inspection path are constructed for efficient fire prevention. Of these, priority areas are identified and a total of 100,000 acres of natural forests had been specially protected each year since 1997/98. In addition, approximately 1.8 million acres (1.09 ha) of degraded forests have been earmarked for conversion to closed forests by natural means during the 30 years of the Master plan.

(b) Initiating Development and Utilization of Wood Fuel Substitutes

Wood Fuel consumption is one of the main causes of deforestation, and excessive cutting of trees for firewood before they are fully grown, leads to the loss of growth potential of the forest stands. In most developing nations more than 80% of wood extracted are being used for fuel. In Myanmar too, illegal extraction of trees for firewood and charcoal has been a major cause of deforestation and forest degradation.

Therefore, Forest Department had launched fuel wood substitution programme to reduce pressure on the utilization of wood for fuel. The DZGD since its creation in 1997 had distributed some 100,000 efficient cooking stoves and 9.2 million numbers of briquettes (7.4 million kg), and the use of 45,000 metric tons of agricultural residues by villagers in the dry zone was also recorded over the same period. Distribution of efficient cooking stoves and briquettes and the use of agricultural residues in place of fuel wood were found to have surpassed the targets adopted by DZGD for the years 1997/98 and 1998/99. In support of forest protection and conservation, wood fuel substitution has been identified as a main task of the DZGD. Three activities have been carried out as follows:

(i) Distribution of fuel efficient stoves
Total numbers of 94,628 A-1 cooking stoves were distributed in 1998/99. About 40,500 numbers of A-1 cooking stoves are to be distributed in 1999/2000 and all the necessary arrangements have been undertaken.

(ii) Promotion of fuel briquette production and utilization
In 1998/99, 8.35 million fuel briquettes were distributed for wood fuel substitute activities. Fuel briquette mills would be set up in Sagaing township of Sagaing Division and Yezin of Mandalay Division for mass production of fuel briquettes. It is targeted to distribute about 7-million fuel wood substitute in 1999/2000.

(iii) Utilization of agricultural residues

To promote wood fuel substitutions, utilization of residues of agricultural crops such as stalks of sesame, pea, cotton, peanut husks and etc, are to be encouraged. In 1998/99 nearly 34, 000 tons of agricultural residues were used as fuel. It is targeted to use 14,000 tons of agricultural residues as fuel in 1999/2000.

(d) Water resources development

Rains fall only in a few days annually and water is very scarce in the Dry Zone. This constitutes the biggest obstacle to green the Dry Zone. It is thus imperative to construct check dams and ponds to collect rainwater, and to tap underground and river waters by pumping in order to assist greening activities and the local needs.

In 1998/99, the DZGD has been able to construct 170 ponds and 12 tube wells. The biggest success in water resource development is the success in implementing Tant-Kyee Taung water distribution programme. Under this programme water from the Ayeyawady River is pumped to the top of the mountain, which is 1, 024 feet above sea level and about 6980 feet away from the river. The main objective of this programme is to help reforest the very degraded and steep sacred mountain. In 1999/2000, it is targeted to construct 170 ponds, 5-tube wells and 171 check dams by the DZGD. (National Report of Myanmar on UNCCD)
4.8 Summary

In contrast to many other countries, Myanmar has experienced less environmental degradation and pollution problems. However, the country faces some local environmental issues arising mainly from underdevelopment and poverty.

Firstly, there is the problem of deforestation. In Myanmar, more than 90 percent of renewable energy consumption depends upon forest resources. Few rural homes in Myanmar have supply of gas or electricity, thus, there is a heavy reliance on wood fuel resulting in depletion of forest cover. During the 14 years period from 1975 to 1989, the total forest cover had been reduced at a rate of 115100 ha per year. Deforestation is also due to shifting cultivation, which is practiced by about 2.6 million people mostly, living in the hilly areas covering about 142,000 hectares. Most of the shifting cultivators are unaware of the damage caused to the environment by their traditional farming system. But, unavoidably, the hilly region people still have to rely on the shifting cultivation because it is the only way of cultivation, which can be done to grow the staple crops on the mountainous woodland. The problem of deforestation is very serious in two regions. The first one is Central dry Zone of Myanmar. Due to high population and very low rainfall, the area is very seriously affected and sustainable agriculture is faced with problems of land degradation and desertification. For this reason, government is supporting new initiatives for rehabilitation and reforestation in this area through the Dry Zone Greening project. The second region that needs attention is the Mangrove forest area of the Ayeyawady Delta. In this area the deforestation is high and entire mangrove forests were wiped out within two decades (Myint, 1995a). UNDP/FAO is operating in the area through community development programs to save the mangroves. (Myint, 1995b).

Secondly, there is a problem concerning loss of biological resources. Wildlife in Myanmar is presently being threatened and endangered as a result of habitat loss, hunting and poaching. It is estimated that there are 34 endangered species including 11 reptiles, 4 birds and 19 mammal species.
Thirdly, is the problem of pollution. However, currently the extent of industrial pollution and accompanying environmental degradation is rather localized. The degree of air and water pollution caused by industry or agriculture has been minimal due to the low level of industrialization and relatively small amount of chemicals used in agriculture. The data on sources of inland water pollution as well as data on air pollution and air quality are not available. There are no air pollution and air-quality monitoring stations and automobile exhaust monitoring stations in Myanmar. However, pollution from vehicles is also not significant and to at present Myanmar has not encountered serious problems concerning marine pollution. Indoor air pollution may exist but the danger has not been fully recognized. Surface waters to which people have access are sometimes found to be contaminated with fecal matters. Waste matter mainly due to unprotected wellheads and lack of drainage can also contaminate hand-dug wells. Ground water can also be affected by solid and liquid waste dumped onto ground.

Fourthly, land degradation through wind and water erosion is also found to have occurred in areas where deforestation has taken place. Soil erosion is especially found in the barren plains where the topsoils are blown away by wind. Water erosion also occurs along the slopes of denuded hills when heavy rains wash down the topsoils. The arid zone in central Myanmar is prone to wind erosion. The Central Dry Zone areas have relatively less trees and vegetation due to low rainfall. Indiscriminate felling of trees for wood fuel has aggravated the situation. With regard to national disasters, the occurrence of earthquakes, landslides, and famine due to droughts are negligible in Myanmar. Though there are cyclones and floods during the monsoon months, their occurrence is neither frequent nor devastating.

Finally, according to the assessment, the yield of teak, at current yield 4000 thousand m³ would have be supplemented in 2003 (Myint, 1981, Tint & et al, 1993). In the case of other species, the yield from natural forests would be substantial and the plantation yield would be lesser than the yield of natural forests. Because the natural forests are inaccessible and the extraction is not possible and expensive. Plantations are very accessible and the final crop yields can be very economically important. Teak yield
reduction in Myanmar is due to over exploitation especially in accessible areas. This can be recovered by providing rest period and proper silviculture operation. It is to be noted that plantation yields can be very high quantatively and economically. More emphasis should be given to the plantations with the higher investment. Sustainable forest management needs to account for the environmental services of the forests; only emphasizing the timber or non-timber forest at a sustained basis is not adequate. With the population growth and development, priority should be given to the conservation and sustainable management of the forest resources at both national and regional level.